Popular Astronomy

Vol. XLII, No. 10 **DECEMBER, 1934** **Whole No. 420**

Goodwin DeLoss Swezey

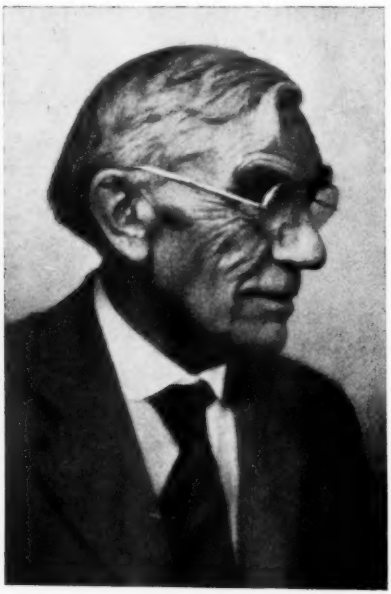
By W. C. BRENKE

In this rather intimate narrative of the life and work of a pioneer in science the writer begs a little indulgence if he seems to do more than make a cold, dispassionate appraisal of the merits of one whose activities can be judged only in the light of his unusual personality. Patient, kindly, inquisitive, inventive, resourceful, modest to self-effacement, slight in physique but strong in vital energy, he made the best of facilities which were ever all too slender, lived his life in his work, and pursued his tranquil course undisturbed by those mundane events which troubled most of his fellow mortals.

Born in Rockford, Illinois, on January 10, 1851, he was educated in Beloit College, where he received the degree of A.B. in 1873. He had taken the classical course with a view to preparing for the ministry, but was equally interested in scientific studies and had done a large amount of work in the fields of botany, zoology, and geology. This work in the line of science he was moved to follow up by a year of post-graduate study at the Sheffield Scientific School of Yale University (1873-4), at the end of which he was called back to Beloit to begin his work in teaching as an instructor in natural sciences. From that time until his death, sixty years later, he devoted himself almost wholly to the teaching of science, dividing his time during the first twenty years among several departments and in the last forty years confining himself mainly to astronomy. While instructor at Beloit, he received the degree of A.M. in 1876. Three years later he spent a year in studying at Andover Theological Seminary where he received the degree of B.D. in 1880.

The broad preparation which he now had in the classics, science, and theology led to his appointment as Professor of Natural Sciences at Doane College, Crete, Nebraska, a Congregational denominational school. That he made an impress during his fourteen year tenure at Doane College, (1880-1894), is clearly evidenced by the fact that today, forty years after he left there, he lives in the esteem and affection of all who were associated with him as colleagues or as students. His activities during these years were legion. As teacher of geometry he worked independently of the text and required his students to spend most of their time on original problems. As teacher of English, a duty that fell to every instructor at Doane in those years because of an arrangement whereby the students were assigned in groups to faculty members for instruction in writing and speaking, he made a long list of commonly misused or mispronounced words, wove them all into a story and re-

quired his students to read it aloud. He prepared a fairly complete list of the butterflies of the locality and a pamphlet on crustaceans. When confronted with an unusual specimen of butterfly collected by a student, he promptly and correctly identified it as an albino form of a well-known species. He would come to his class in zoology wet to the knees from a hunt for a specimen he desired to use for his lecture. The college museum still contains a large number of specimens of birds and small mammals and even a wolf, all of which he stuffed and mounted with his own hands. (It may be stated here parenthetically that certain deformi-



GOODWIN DE LOSS SWEZEY
1851-1934

ties of his fingers, which seemed as though they might make delicate work impossible, were due to the fact that he played baseball on his college nine in the days when gloves had not been thought of. Nevertheless the deftness of his fingers was quite uncanny.) The museum also contains collections of insects, shells, minerals, crystals, fossils, all prepared by this indefatigable professor. He constructed an excellent microtome which was considered by the entomologist at the State University, Professor Bruner, to be superior to his own factory built model. These interests as a naturalist he retained through all his life and in his later years, when entirely occupied during the school year with astrono-

my, spent much time during the summer in long excursions into the western mountains.

Within three years after his arrival at Crete he was called upon to plan an observatory, the gift of Mr. Charles Boswell, of Hartford, Connecticut. It was completed in 1883 and Professor Swezey became its first director. The equipment included an 8-inch refracting telescope with Clark lens, a Howard clock, and meteorological instruments. In those early days laboratory facilities for students of science in our colleges and universities were slight, in the middle west almost unknown. After his many labors with home made facilities in the other branches of sciences which he had been teaching, this fine observatory was to him a jewel without price, and he threw himself whole heartedly into the work of kindling terrestrial minds with sparks of celestial fire. He had already instituted a regular volunteer weather service at Crete and was now made director of the Nebraska Weather Service, a post which he held during twelve years. His activity in this department brought about the establishment at Doane College of a federal weather bureau, with a government meteorologist, Mr. G. A. Loveland, in charge. Professor Swezey established a local time service whereby the people of the town and adjacent farms were given the correct time each noon by the dropping of a time ball placed at the top of the main college building. He instituted regular popular lectures on scientific subjects, which some of those who heard them still recall with enthusiasm. He had a faculty of giving something to all who came, whether young or old, whether student, teacher or layman. His lighted lantern, hung at the top of the observatory dome as an announcement of the lecture on astronomy, was eagerly looked for by all within range of its rays. One of his daughters tells of a story of this ability to gather and hold an audience. On the occasion of a visit to the Adler Planetarium he was answering a question asked by a man standing in front of a display of astronomical photographs. As he spoke his audience began to grow so that he had to raise his voice, and soon he was conducting a tour of the exhibits, followed by a large group of people all interested to hear him, by voice and gesture in characteristic style, expound the wonders of the heavens. He engaged in various extra-curricular activities. He organized a college glee club, whose annual concert, under his direction became a campus event; took an active part in his church as a member of the choir and superintendent of the Sunday School; he organized a chautauqua lecture circle and brought to Crete many interesting programs and persons.

In 1894 Professor Swezey was called to the position of Professor of Astronomy and Meteorology in the University of Nebraska at Lincoln. The work in meteorology at first took much of his time but after a few years, with the establishment of a regular federal weather bureau at this station, this was delegated to others, leaving him free to give his time to astronomy. In 1899 he had his first assistant, a graduate student named Joel Stebbins. Thus he repaid a debt contracted in his early years when he went to Washburn Observatory for summer study under

the inspiring guidance of Professor G. C. Comstock, by initiating the present director of that observatory into the mysteries of the starry universe.

Following out his mechanical bent, he designed and had made, or himself made, many pieces of apparatus which are still in use, including a chronograph, a heliometer, and a spectroscope. He devoted much time to preparing illustrated lectures and accumulated a fine collection of some twelve hundred slides, more than half of which were made by himself, largely from original drawings. He became acquainted with Dr. C. H. Minnich, of Palmer, Nebraska, a physician with a hobby for grinding lenses. Professor Swezey now conceived the idea of supplementing his small telescope by a larger instrument; Dr. Minnich would grind the lenses and he himself would design the mounting and have it made in the shops of the College of Engineering. Accordingly he secured funds for the purchase of two discs of glass for a 12-inch lens from a German firm at Jena, and turned these discs over to Dr. Minnich, who spent approximately a year in the process of shaping them. Professor Swezey tested the lenses at various stages and after a number of trials and corrections, they were judged to be satisfactory (August, 1906). He now sketched preliminary plans for the mounting, incorporating the best features of various mountings which he had studied. A complete set of blue prints and specifications was then drawn up, patterns were made in the University wood shop, castings were made in the foundry, the parts finished in the machine shops. It was inevitable that this work including 319 pieces, done piece-meal by students, should progress but slowly. However, after eight years the whole mounting was assembled and displayed by the Engineering College in 1915. Having at hand now lens and mounting, except graduated circle and driving clock, he sought funds for the building of an observatory for which he had drawn up complete plans and specifications. Here he was less successful and it was no doubt the great disappointment of his life that he was never able to see this instrument, to the production of which he had given so much thought and time, put into action. Though the failure to realize this long cherished dream, despite renewed efforts, weighed heavily upon him, he continued at his work of teaching and writing, devising for his students interesting projects which could be carried out with the available equipment, holding open nights for the public, responding to calls for lectures, and taking an active part in scientific affairs on the campus through the Nebraska Academy of Science and of the Society of Sigma Xi.

Scientific papers by Professor Swezey appear in numerous publications such as: Geology of Wisconsin; Wisconsin Academy of Science, Transactions; Publication of Nebraska Board of Agriculture; Nebraska Horticulture Society; Nebraska Academy of Science; Science; Popular Astronomy. The list of papers includes some half hundred titles and is too long to be quoted here. A selection from these titles will be of interest as illustrating his many-sided activities: "Catalogue of Exogen-

ous, Endogeneous, and Acrogenous Plants of Wisconsin"; "On some points in the Geology of the Region about Beloit"; "Nebraska Flowering Plants"; "Evidences of two Pre-Morainic Glacial Movements"; "Breathin Wells"; "The Circulation in Fresh-water Mussels"; "Latitude of the Observatory at Lincoln"; "The Leonid Meteors of 1898"; "The present Status of Meteoric Astronomy (1901)"; "The Earth before the Earth-Moon Catastrophe"; etc. Many papers relate to meteorology and its application to agriculture. He is author of one of the earliest, if not the first, laboratory manuals in astronomy, which was followed by a booklet of "Exercises in Astronomy." One of these exercises is entitled "The Lillie Murder Case," its basis being a case in which Professor Swezey was called to testify as to the possibility of a certain position of the moon at a stated time. It is but one illustration, which might be multiplied a hundred fold, of his original use of material in teaching. Among his last publications is "Boys Book of Astronomy" (Dutton, 1929).

In the year following the building of the observatory at Doane College, Professor Swezey was married to Mary Frances Hill of Beloit, Wisconsin, and the observatory was their first home. The great tragedy of his life came when she passed away in 1891 after a brief married life of but seven years. He did not marry again, and his simple wholehearted devotion to his three small daughters, whom he made his constant companions until they reached maturity, exhibits his character in one of its finest lights. With the passing years each daughter found her own niche in life and he was left to sole communion with the stars. Nor did he repine but kept busily at his work, all day long and many hours of the night during the academic year; then off for a summer of travel and study. This took him during many summers to the home of his eldest daughter in California, whence he made many trips to Mt. Wilson Observatory and where, in August, 1934, his long and active career came to its close. He had lived a full life, had borne reverses with equanimity and fortitude, and had enriched the lives of many by his scientific teaching and his genial philosophy.

LINCOLN, NEBRASKA, NOVEMBER 3, 1934.

A Telescopic Meteor

By RAYMOND S. DUGAN

On October 12, 1934, at 9:56 P.M., Eastern Standard Time, while I was observing SU Aquarii with the polarizing photometer on the 23-inch telescope, a meteor flashed across the field of view. I had just taken off the Nicol prism to make sure that the stars were centered. The flash was startlingly bright. The motion was so rapid that I could only just make sure that it was from left to right. A fainter streak went across the lower part of the field parallel to the principal one. The

latter was a broad, blinding flash but the former, which was probably due to reflections from some of the twelve optical surfaces of the photometer (exclusive of the Nicol prism), left a clear impression of direction. When I noted the hour angle at which I was observing and the relative positions of SU Aquarii and the comparison star I was using, I realized at once that the motion took place very approximately parallel to the line joining the two achromatic prisms which one slides up toward the objective to bring the variable and the comparison stars together, and consequently at right angles to the line joining the two stars.

Knowing that SU Aquarii and BD —13°6290 were together at the center of the field, knowing the size of the field and retaining a picture of the position of the faint streak, I was able to conclude that the meteor passed very approximately through $\alpha = 22^h\ 48^m.9$, $\delta = -13°\ 28'$ (1930.0) with a motion represented by the corresponding values $\Delta\alpha = +1^m$, $\Delta\delta = +6'$.

I was not quick enough to manipulate the photometer and measure the brightness of the meteor. The breadth of the streak makes an estimate difficult, but I think it must have been well up toward the first magnitude. The Wollaston prism throws one beam off at quite an angle so I was unable to make any estimate of polarization.

An estimate of the width of the bright streak is valueless on account of the chromatism of the achromatic prisms which becomes pronounced for so bright an object. The faint streak, however, gave a clear impression of width, of the order of 10″. If the meteor passed at a height of 50 miles the luminous surface must have had an effective diameter of some thirteen feet.

I was reminded of another night when I also set the circles for SU Aquarii, turned the dome, maneuvered the observing chair into position, climbed up with my observing book and watch, settled myself, and looked in the 6-inch finder just in time to see an M-type point of light streak across the field. At first I thought of a meteor but then I realized that, with the magnifying power, the motion had been much too slow. Listening, I heard the drone of an airplane. The chances of this also must still be small.

One should not be led into calculating the chance that an observer of eclipsing variables during his lifetime see both a meteor and an airplane pass across the same field of view, for an observer should not make a random choice of stars for observation. Also the airplanes on the New York-Philadelphia run have a habit, at this time of year, of flying through Aquarius.

Princeton University Observatory.

E. E. Barnard's Visit to G. Schiaparelli

The following notes were recently found by Miss Calvert in the files of the Yerkes Observatory. They were written in the summer of 1893 when E. E. Barnard paid a visit to the Brera Observatory at Milan, made famous by the work of G. Schiaparelli. We find here an exact record of a conversation between the two great observers. Neither one was conversationally versed in the other's language, but both were determined to discuss matters of common interest and they, therefore, conversed in writing. Some of the sentences are incomplete and not everything was written down. But even so, the document contains enough of scientific and personal interest to warrant its publication. The great humility and urbanity of the Italian astronomer and the impetuous inquisitiveness of his American counterpart are brought out here in striking contrast. The facsimile reproduction shows a sample of the two handwritings, Barnard's writing is at the top.

G. VAN BIESBROECK.

July 31, 1934.

SCHIAPARELLI. We can speak by writing.

BARNARD. In coming to Europe one of my great desires was to see you and to visit your observatory. I shall be in Milan today, and will proceed on my journey tomorrow.

S. Our Observatory is not very worthy of seeing, but I can show to you what we have, good or bad.

B. I have been to Paris, Marseilles, and Nice, and saw Tisserand, Loewy, Freres Henry, Stephan, Borrelly, Perrotin, and Charlois last week.

S. Shall we proceed at once?

B. Yes, if you please. I have brought with me, to show you, some photographs of the Milky Way and of Comet Swift, 1892.

S. I shall see them with the greatest pleasure.

B. Can we see them better from the observatory? They are on glass and are to be held up to the light of the sky. I will now show you the photographs. It is impossible to photograph these clouds of stars in the Milky Way with a great telescope.

S. Have you made the photographs of the Milky Way with a portrait lens also?

B. Yes, these photographs of the Milky Way were made with the same 6-inch portrait lens that was used for the comet. I would like to see your drawings of the planets.

S. I shall show them to you with pleasure.

B. Were they made with your 18-inch telescope?

S. I have made them with an 8-inch and with the 18-inch. The latter instrument I have used since 1886, the 8-inch before 1886.

B. Is the atmosphere steady here in the day time? It is always unsteady in the day at Mt. Hamilton. We cannot, therefore, observe either Venus or Mercury when at any altitude above the horizon.

S. Such observations are possible here in winter, autumn and spring.

In summer the agitation in day-time is always very great.

B. It is *always* bad at L.O. in day time . . .

S. These are old instruments out of use now. Oriani and the ancient astronomers have used them a century ago.

B. Mr. Burnham said that your telescope and your eye were both very fine to have discovered this difficult double star.[1]

S. But I cannot employ amplifications more than 1050. Mr. Burnham uses 3000 with the 36-inch at Mt. Hamilton.

B. Yes, but he very seldom uses such a great power. He usually uses 350-520 and 1000. The higher powers he uses only under the very finest conditions of the atmosphere, and then only two or three times in the season. He prefers the more moderate powers.

S. We have here not more than 200 hours yearly, which give sufficient conditions for use of high amplifications from 400 upwards.

B. Often the wind blows strongly on good nights in the summer and prevents the use of anything but the lower powers, as it shakes the telescope badly.

S. The wind is here most annoying also. The best conditions are here with East wind, with moderate velocity. Strong wind gives always bad seeing. Our position in the middle of a great town is a great drawback.

B. Is it possible that you may some day get away from the town out into the country with your observatory? To remove it from the city.

S. I hope so, but the time for this is not near.

We can now see the drawings of the planets if you like it.

B. You make two settings for Position Angle, and two *double* distances. Mr. Burnham makes four settings for P.A. and three double distances.

S. The good time for observations is here so scanty that we must make the measures in the shortest possible time. Therefore it is better to make more measures in different days, and be content with a lesser number of settings.

B. The old observers used to make all the measures on one night, but that is not a good way.

You are absolutely certain that Venus and Mercury revolve once on their axes while revolving once around the Sun?

S. For Mercury I have not the slightest doubt; for Venus the observations are too scarce and somewhat doubtful; the rotation I regard as probable but not as definitely settled.

B. I have some drawings of Venus made one day in 1889 (August) when the air was filled with smoke and dust. I saw the markings very plainly, but have never seen them since. If you like I will send you these drawings of Venus.

S. I shall be very thankful for it.

[1] Almost certainly this double star is ε Hydrae.

B. Do you think the surface of Mars is in a stable condition? Is it not changing very much in the lesser details?

S. The great configurations are stable in outline, but not in colour; there are moreover very considerable changes in the lesser details. This drawing is made on the very day I have made the first constatation [observation] of double lines.

B. What is your explanation of the enlargement of the Lacus Solis?

S. I have no explanation!

B. Has the Lacus Solis ever been seen so large as it was at the last opposition?

S. No. The dimensions and the darkness of its tint are variable. In 1877 this spot was perfectly round—in other years somewhat elliptical.

B. I have a great many drawings of Mars, made at the last opposition of the planet, which I shall publish when I return to the L.O.

S. I shall subscribe then to *Astronomy and Astrophysics.*

B. I shall publish my drawings of Mars in the *Monthly Notices of the Royal Astronomical Society*, and will send you a copy when they are printed.

S. We have the *M.N.R.A.S.* Now I show you the Lacus Solis bisected.

B. Following the Lacus Solis in 1892, was a small dark spot which was very variable in its depth of shade. At times it was almost black, at other times it was grayish and faint.

S. This is the Lacus Phoenicis—in 1877 it was very visible; in the following oppositions it had almost disappeared and now I am glad that you have found it. Last year 1892 the weather has been very bad, and I have not found opportunity of making good observations of the region around Lacus Solis.

B. I have several careful drawings of this region in 1892.

S. Prof. Holden has sent to me some drawings of Lick Observatory. In one of them is Lacus Solis with his surroundings, and a very intricate net of lines around it.

B. This was not my drawing. It was possibly one by Mr. Schaeberle.

S. It was by Mr. Hussey.

B. Am I detaining you too long? I am extremely interested in your work, and want to find out as much about it as I can while in Milan.

S. It is for me a great pleasure to be with you. I will show you my drawings of Venus of the year 1877 which have led me to conjecture its long period of rotation. . . . I have seen them only in 1877. (The white spots at the pole. E.E.B.)

B. Do the dark markings also suggest a slow rotation of Venus?

S. Yes, but these dark markings are so nebulous, that it is dangerous to make use of them for the rotation. The two luminous spots on the upper horn were well terminated; they have been seen by Prof.

Holden in Washington at the same epoch.

B. In observing Venus and Mercury have you ever used a dark glass to cut down the glare? I have tried this but do not think it improves the definition.

S. It may be advantageous when the planets are too near the Sun. I have observed Mercury at 2° from the Sun.

B. Do you think the correction of your objective gives you an advantage in observing a red or reddish object? Is it corrected for the red more than other objectives?

S. Our 8-inch is very favorably corrected for red objects; the 18-inch also, but in a less degree. In both telescopes *blue* objects are badly seen.

B. In observing Mars do you find the 18-inch very greatly superior to the 8-inch?

S. The superiority is considerable; yet the lesser telescope as a 8-inch is better, than the greater telescope as a 18-inch. With Mars I can use the power 420 in the 8-inch; in the 18-inch I can go no farther than 650. Were the two instruments of equal excellence I should go to 420 18/8 or more than 900. But this is not the case.

B. Almost as high a power can be used with the 12-inch of the Lick Observatory, in observing Mars, as can be used on the 36-inch.

S. This is very strange!

B. On Mars I got best results with about 200 with the 12-inch, and with the 36-inch I got the best results with 350.

S. Here, when the weather is favorable the amplifications 200 and 350 are not enough to do justice to the instrument.

B. The low altitude of Mars at the L.O. and the unsteadiness of the atmosphere at the times when I observed Mars, required a low power. I have on very favorable nights used 500 diameters on Mars, but the least tremor of the air is multiplied very greatly with the large telescope.

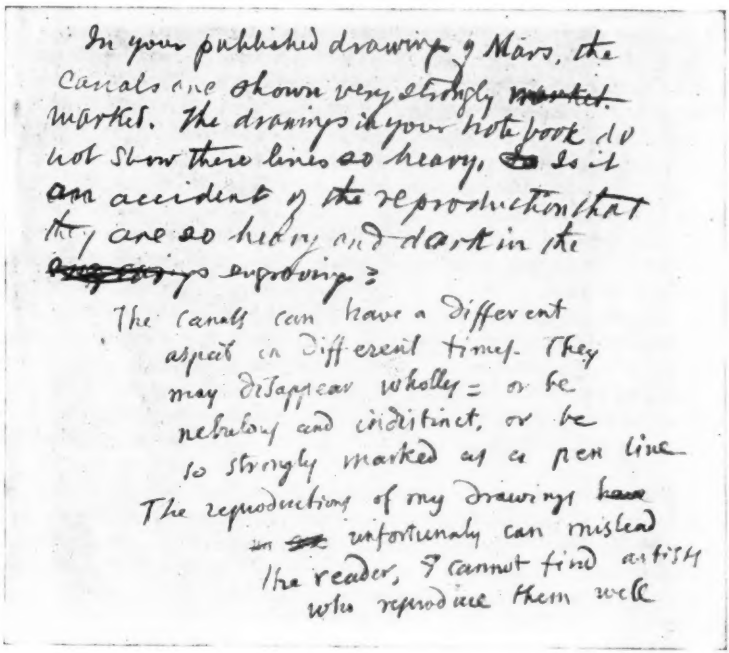
S. I hope in the next opposition you will go farther than that. Here the opposition 1892 has been almost without results.

B. In measuring the P.A. of the axis of Mars, and the positions of the markings, I always used 500. In respect to the clouds on Mars, have you often seen evidence of them? Are they dark or white? I saw in August last a white spot 2″ diameter which was very distinct a little N of the equator; the next day it had wholly disappeared.

S. Such white spots are not infrequent, but I am not sure they are clouds. They may be transient condensations. However, one of these spots has been visible on three consecutive oppositions; it is not probable that clouds may last so long.

B. In your published drawings of Mars the canals are shown very strongly marked. The drawings in your notebook do not show these lines so heavy. Is it an accident of the reproduction that they are so heavy and dark in the engraving?

S. The canals can have a different aspect in different times. They


In your published drawings of Mars, the canals are shown very strongly ~~marked~~ marked. The drawings in your note book do not show these lines so heavy, ~~So~~ Is it an accident of the reproduction that they are so heavy and dark in the ~~copies~~ engravings?

The canals can have a different aspect in different times. They may disappear wholly = or be nebulous and indistinct, or be so strongly marked as a pen line. The reproductions of my drawings ~~in the~~ unfortunately can mislead the reader, I cannot find artists who reproduce them well

FACSIMILE OF PART OF THE CONVERSATION.

may disappear wholly, or be nebulous or indistinct, or be so strongly marked as a pen line. The reproductions of my drawings unfortunately can mislead the reader. I cannot find artists who reproduce them well.

B. Have you any reproductions of your drawings of Mars, Venus, and Mercury that you can let me have? Can you direct me where to purchase photographs of the instruments and of the observatory, in Milan? I should very much like a photograph of yourself. Is there a photograph gallery (studio) in Milan that has photographs of yourself?

S. Unfortunately in this moment I cannot give you a photograph of myself, but I will send you one at your address at the Lick Observatory. I will also give you a drawing of our great instrument and also an exemplar [copy] of three memoirs on Mars, with drawings.

These are my second and third memoirs on Mars. I regret that I cannot present you with a copy of the first.

B. When I return to the Lick Observatory I shall be glad to send you a photograph of myself in exchange for one of yourself which I very much desire to place among my collection of celebrated astronomers.

S. This [indicating the word "celebrated"] is too much.

B. You do not know how greatly American astronomers admire you as an observer or you would not say that.

S. It is for me a great pleasure to have known you, and I hope that from this day we shall continue a friendly relation, which shall be most honorable and profitable for me.

B. It is one of the greatest pleasures of my visit to Europe to have met you, and it was one of my first thoughts when I decided to come to Europe, that I should visit Milan and see Professor Schiaparelli!

S. Thank you.

B. Is there not a photographer in Milan who has photographs of the observatory and the instruments for sale? I wish to purchase some to take back with me.

S. There are not such photographs, but I will have them made and send them to you. Of the great instrument there are some photographs, which I will give presently to you. I had almost forgotten them.

B. I will go now as it is getting late. I wish to see the Cathedral and a few things of interest in Milan and then will continue my journey. Do you live at the observatory? That is, is your home at the observatory?

S. Yes, we have our habitation in the same building.

B. I am extremely obliged to you for your kindness. I hope that you may be able some day to come to America and see the people of the United States. A most warm welcome awaits you there. I should be delighted to entertain you at my home at the Lick Observatory if you ever come to California.

S. It is my intention to go to America, but not before my service time has expired, that is after 1899. We have time to speak of it.

B. I shall keep these notes to refresh my memory as I shall want to keep a diary of my journey to Europe.

S. It was my desire to keep them, but I will let you have your way. Adieu, and my best thanks for your visit.

Errors in the Periods of Variable Stars

By T. E. STERNE

Introduction

Observations on variable stars are most often made to determine their magnitudes at certain times. The determinations may be visual, or photographic; but for any star that is well observed by either method, there results a set of magnitudes, each for a known date. The magnitudes are then plotted against the respective dates, and a smooth curve drawn through them as well as possible by estimation; this curve is known as the "light-curve." The most obvious and important fact about the light-curves of cluster-type, Cepheid, and long-period variables is their periodicity. The light-curve of any well-studied variable star of one of

these types consists of a succession of nearly equivalent cycles, each recording a rise from minimum to maximum brightness, and a subsequent fall to the following minimum. If the star were exactly periodic, and if the observations were perfectly precise, these cycles would be identical, and the complete light-curve could be cut into parts that could be superposed on one another precisely. The length of a cycle would be called the "period" of the star. In practice, the observations are never perfectly precise, and for this reason alone the successive cycles can never be made to coincide exactly. In addition there sometimes appear to be differences between the cycles too large to be accounted for in this way, and which could only have arisen from departures of the star itself from perfect periodicity. To determine the "period" of a well-observed variable star, the light-curve is divided into cycles as nearly similar to each other as possible, and these are superposed on one another. A "mean" light-curve is obtained, representing an average cycle, by drawing a smooth curve as well as possible through the observational points of the superposed individual fragments. On this mean curve a mark is made, either at some definite point like the maximum, or quite arbitrarily; where it is does not matter, the mark is merely a reference point. The mean curve is then superposed in turn on each individual fragment so that all the parts coincide as well as possible, and marks are made on the individual curves under the mark on the mean curve. The average interval, in Julian days, between successive marks is known as the "period" of the star. The above procedure[1] is not always followed; sometimes the marks on the individual fragments are made by estimation at the maxima, at the minima, or at certain magnitudes; but these procedures are always inferior in accuracy because of their greater liability to observational error. It is only by basing the mark upon *all* the observed parts of a cycle that the effects of observational errors, and small erratic fluctuations in the star itself, can be minimized.

To save words in the following discussion, let us call the date associated with a certain cycle the "date of maximum," it being understood that the expression "date of maximum" can be replaced by "date of minimum," "date of m magnitudes increasing," etc., in the applications to stars for which any of these latter dates are used. If any variable star were exact and constant as to period, a schedule could be computed for dates of maximum, past or expected, based on one observed date and successive additions of the period, thus:

$$C = A + NP$$

where C is the computed date, A is a constant, P is the period, and N is the number of cycles elapsed since the date of maximum A. The computed dates C would agree with the observed dates, O say, and $O - C$

[1] Habitually used in the reduction of observations by the Recorder of the A.A.V.S.O. The dates are published as "dates of maximum," etc., but really correspond to arbitrary marks on the mean light-curve. I am indebted to the Recorder for this information.

would be zero. A plot of $O - C$ against N would yield a set of points lying precisely along a straight line. But the observed dates O will in practice always contain errors of observation, and A may not have been chosen quite correctly; so that for a variable star of exactly constant period, the plot of $O - C$ against N will be a set of points lying more or less closely along a straight line of ordinate $O - C$ nearly zero, but with no general tendency for the points to follow a curve of any sort. Such $O - C$ diagrams are in fact obtained for certain variable stars, and indicate the constancy of their periods. Yet it is not true that curvatures in the $O - C$ diagrams always indicate changes of period. Changes of period will be reflected in the $O - C$ diagrams as curvatures, true enough; but such curvatures can also be caused by the accumulation of random errors in the lengths of the cycles of the star itself.

The existence of cumulative errors in the time-keeping mechanisms has long been recognized, and the possibility of the existence of cumulative errors in sun-spot cycles was considered, and rejected, by Newcomb.[2] The existence of cumulative errors in the periods of long-period variable stars was inferred by Eddington and Plakidis.[3] Recent and independent investigations[4] by the author have confirmed the results of Eddington and Plakidis, and have in addition revealed the presence of cumulative errors in short-period Cepheid-type variables, and even in eclipsing binaries. One should expect to find cumulative errors in the periods of pulsating fluid stars, owing to imperfections in their mechanism; and the results for long-period variables and short-period non-binary variables are not surprising. Although at first sight errors of time-keeping are somewhat surprising in eclipsing stars, such fluctuations are by no means impossible dynamically, and can arise from oscillatory changes of shape, induced in the component stars by the orbital ellipticities, producing in turn slight changes in the attractions. But whatever the reasons may be for these errors of period, their existence renders the inference of changes of period, from curvatures of $O - C$ diagrams, liable to fallacy; and it therefore becomes important to discover the effects of such errors on computed periods, and on $O - C$ diagrams. What follows will be illustrated by two long-period variables. A more thorough and exact treatment, with a more detailed derivation of the results, will be found in the author's papers previously mentioned.

Estimation of Cumulative and Non-cumulative Errors

Let one suppose that a variable star is analogous to the pendulum of a clock, the balance wheel of a watch, or to any other cyclical mechanism; then, even with observations of the highest precision, the individual

[2] Newcomb, *Ap. J.*, **13**, 1, 1901.

[3] Eddington and Plakidis, *M.N.*, **90**, 65, 1929; Plakidis, **92**, 460, 1932; Plakidis, **93**, 373, 1933.

[4] Sterne, *Harvard Circulars* 386-387, 1934.

cycles[5] of the star must still differ from one another by small amounts, in a random fashion, because of imperfections inherent in the star's mechanism. The numerical value of the "true period" of the star may be defined as the limit approached by the mean (the sum divided by the number) of the cycles as the number of cycles is increased without limit. Over any finite run of the sort that one must deal with in practice, the mean of the cycles will not exactly equal the true period, because of irregularities of sampling. Some runs will contain an unduly large, others an unduly small, proportion of long cycles. As we obtain, however, an increasingly numerous, and hence "fairer," assortment of cycles, the effects of fluctuations of sampling[6] diminish.

Consider the case of a star whose true period, $\boldsymbol{P}$, is not changing. If s is the standard deviation (the square root of the mean of the squares of the residuals, $P_i - \boldsymbol{P}$) of the individual cycles from $\boldsymbol{P}$, then the standard deviation from $n\boldsymbol{P}$ of the sum[7] of n cycles is $n^{1/2}s$. Such cumulative errors, caused by irregularities of running, should be expected to be present in variable stars; but there will be present as well the non-cumulative errors of observation combined, perhaps, with non-cumulative errors of the stars themselves. It is clear that random changes in the shape of the light-curve will contribute to the residuals in precisely the same way as will errors of observation. Such errors are related not to the cycles between maxima, but merely to the observed dates of maximum. The standard deviation of the cumulative errors will be denoted by s, while that of the non-cumulative errors will be denoted by e; e^2 will thus contain a part arising from errors of observation, while the remainder will come from temporary irregularities in the star itself.

By numerical analysis of the observed dates of maximum, we shall establish the result that in some stars, at any rate, errors of period exist of the first sort mentioned above. Consider a variable star over a run of E cycles from T_0 to T_E. The quantity $T_{i+n} - T_i$ differs from $n\boldsymbol{P}$ by

$$\epsilon_{i+n} - \epsilon_i + v_i + v_{i+1} + \ldots + v_{i+n-1}$$

where ϵ_i is the non-cumulative error of the i'th date of maximum, and v_i is the cumulative error of the i'th cycle. Hence the (standard deviation)^2 of $T_{i+n} - T_i - n\boldsymbol{P}$ is $2e^2 + ns^2$ by the rule for the composition of independent errors. If we compute[8] $\sigma^2_n = \overline{(T_{i+n} - T_i - nP)^2}$, where P is the mean period over the whole run, and plot σ^2_n against n,

[5] The difference in time between any two consecutive dates of maximum is called a "cycle" of the star. The observed dates of maximum being denoted by T_0, T_1, T_2, etc., the difference $T_{i+1} - T_i = P_i$ will be called the i'th "cycle."

[6] For an introduction to the theory of samples, and to the properties of the standard deviation, about to be employed, the reader is referred to any introductory book on statistics. Yule's *Introduction to the Theory of Statistics*, Griffin & Co., London, 1924, covers the field in a thorough but non-technical fashion.

[7] The square of the standard deviation of the sum of a number of independent quantities equals the sum of the squares of the individual standard deviations.

[8] Bar denotes mean value.

the points so obtained should therefore fall nearly upon a straight line, whose slope is s^2 and whose intercept on the vertical axis $n=0$ is $2e^2$. We here ignore all refinements such as those, for instance, which take into account the difference between P and $\boldsymbol{P}$; more accurate methods will be found in reference 3. If the straight line is parallel to the axis $\sigma^2_n=0$, then all the error is non-cumulative; if it passes through the origin, all the error is cumulative; in any case, the existence of cumulative error is demonstrated by a slope that is greater than zero. Such a plot for the long-period variable RR Scorpii, from the data to be presented shortly, appears in Figure A, in which the time is reckoned in days. It is seen that the slope is distinctly positive, and that therefore

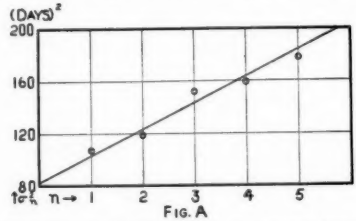


FIG. A

PLOT SHOWING THE EXISTENCE OF CUMULATIVE ERROR IN THE PERIOD OF RR SCORPII.

cumulative error is present. In fact, these rough considerations show that for RR Scorpii, $s=4^d.5$ and $e=6^d.4$, approximately.

The computations are as follows: We have the dates of maximum of RR Scorpii, as published by Leon Campbell in *Harvard Bulletin* 846. The additional, starred dates were very kindly supplied to me by Mr. Campbell from the observations of members of the A.A.V.S.O. The dates were obtained by using mean light-curves, as already described, and constitute a set of data extending from May, 1846, to August, 1933, that is almost complete from December, 1892 ($N=61$) to the latter date ($N=114$). The epoch number is denoted by N, the Julian day of maximum by T.

TABLE I.

N	T (Max.) J.D. 2,400,000+	$(O-C)$					
61	12431	0	18	18	22	9	6
62	12729	18	0	4	— 9	—12	—12
63	13010	18	4	— 9	—12	—12	—17
64	13294	22	—13	—16	—16	—21	—16
65	13561	9	— 3	— 3	— 8	— 3	—10
66	13839	6	0	— 5	0	— 7	5
67	14119	6	— 5	0	— 7	5	16
68	14395	1	5	— 2	10	21	— 4
69	14680	6	— 7	5	16	— 9	0
70	14953	— 1	12	23	— 2	7	— 4
71	15246	11	11	—14	— 5	—16	9
72	15537	22	—25	—16	—27	— 2	8
73	15792	— 3	9	— 2	23	33	29
74	16082	6	—11	14	24	20	15
75	16351	— 5	25	35	31	26	38

N	T (Max.) J.D. 2,400,000+	$(O-C)$					
76	16656	20	10	6	1	13	4
77	16947	30	— 4	— 9	3	— 6	
78	17223	26	— 5	7	— 2		
79	17498	21	12	3			7
80	17791	33	— 9			— 5	—23
81	18062	24			4	—14	
82							
83							
84	18907	28	—18			—17	—13
85	19170	10			1	5	— 8
86							
87							
88	20012	11	4	— 9	19	6	13
89	20296	15	—13	5	2	9	9
90	20563	2	28	15	22	22	17
91	20872	30	—13	— 6	— 6	—11	—20
92	21139	17	7	7	2	— 7	— 3
93	21427	24	0	— 5	—14	—10	— 2
94	21707	24	— 5	—14	—10	— 2	—16
95	21982	19	— 9	— 5	3	—11	—14
96	22254	10	4	12	— 2	— 5	— 3
97	22538	14	8	— 6	— 9	— 7	— 4
98	22826	22	—14	—17	—15	—12	—10
99	23093	8	— 3	— 1	2	4	— 2
100	23370	5	2	5	7	1	— 3
101	23652	7	3	5	— 1	— 5	— 3
102	23936	10	2	— 4	— 8	— 6	— 8
103	24218	12	— 6	—10	— 8	—10	—14
104	24492	6	— 4	— 2	— 4	— 8	— 9
105	24769	2	2	0	— 4	— 5	—13
106	25051	4	— 2	— 6	— 7	—15	—15
107	25330	2	— 4	— 5	—13	—13	—21
108	25606	— 2	— 1	— 9	— 9	—17	—10
109	25885	— 3	— 8	— 8	—16	— 9	3
110	26158	—11	0	— 8	— 1	11	
111	26438	—11	— 8	— 1	11		
112	26710	—19	7	19			
113	26998	—12	12				
114	27290	0					
Sums of squares, last five columns:				5017,	5255,	6684,	6995, 7456.
Means of squares, last five columns:				107,	119,	152,	159, 178.

We find P over the run from 61 to 114 by subtracting the J.D. of maximum corresponding to epoch number 61 from the J.D. of maximum corresponding to epoch number 114, and dividing the difference by the difference (53) between 114 and 61. The result is $280^d.36$. This is a provisional value of the period. The simplest way to obtain the quantities $T_{i+n} - T_i - nP$ is to compute the dates C to be expected in the absence of errors; and thence $O - C$ which equals $T - 2412431^d - 280^d.36 \times (N - 61)$. These values appear in the table above. The differences between successive O—C's, shown in the fourth column, represent values of $T_{i+1} - T_i - P$; the next column contains the differences between $O - C$'s taking them in intervals of two at a time, namely $T_{i+2} - T_i - 2P$; the next column contains the differences between $O - C$'s taking them in intervals of three at a time; and so on, up to five at a time. The differences should not be computed above 1/10 or

1/8 of the number of cycles in the run, because the random errors of σ^2_n are so large as to make it practically meaningless for larger values of n; it is for this reason that we stop here with $n = 5$. Values to the nearest day are sufficiently accurate. The sums of the squares of the differences appear below the table, and the means of the squares are the values of σ^2_n entered in Figure A. They are obtained by dividing the sum of the squares by the number of squares, in each case. The missing entries are due merely to the incompleteness of the data, and cannot influence the results appreciably.

The existence of cumulative errors entails important consequences. Values of $O - C$ will change irregularly as the epoch number increases, because of the existence of cumulative errors in the period of the star, apart from all other changes. Secondly, apart from all changes of the true period of the star, a mean value of the period, calculated from observations over a certain finite run, will be liable to errors of sampling. We shall indicate the method of obtaining, after e and s have been found, not only a "best approximation" to the period but also its standard, or "mean," error with respect to the true period over the given run. It is possible to decide, in cases where different mean periods are obtained for the same star over different runs, whether those means differ from one another by amounts that are significantly large in comparison with the random errors of sampling to be expected; and thus to decide whether or not one is warranted in inferring, from the observational data, the existence of changes of true period.

No "change of period" can be accepted as being real unless, after a careful study of the magnitude of s, the change is found to be either too large, or if of the "sinusoidal" variety too regular, to be consistent with its being a mere fluctuation of sampling. It is greatly to be feared that future investigations will indicate that a very large proportion of the "changes of period" now recorded in the literature may be identified with ordinary errors of sampling. Many[3, 4] have already been so identified. Such changes of period, however, which may survive examination and emerge not as errors of sampling but as changes of true period, should be of importance in their bearing on questions of stellar evolution.

The "Best Approximation" to the True Period over a Certain Run

Let us consider the star over a certain interval of time, during which the observed dates of maximum extend over E cycles. We have already approximated to the true period by simply subtracting the first date from the last, and dividing by E. It is perhaps to be expected that, by using some larger number of dates of maximum at each end of the run, a closer approximation to the correct, true, period could be obtained. Let us use j observed dates of maximum at each end of the run. To use them, we can write down, in two parallel columns, the first j dates of maximum and the last j dates, respectively. We then obtain j values of

the period, generally different, by treating each row separately in the previous fashion. That is, we subtract each date in the first column from the corresponding date in the second column, and divide the difference by the difference between the epoch numbers. We finally take a grand average of the resulting j values of the period, in an attempt to obtain an improved value of the period. It is shown in reference 4 that the mean error of the period so determined is equal to the square root of the sum of two quantities, of which the first arises from non-cumulative, and the second from cumulative, errors. The first quantity is $2e^2/j(E+1-j)^2$, while the second is $s^2/(E+1-j)$, nearly. It is easy to see what happens as we increase j. E is usually of the order of 50 or more; so, as j increases from unity, the first quantity diminishes while the second increases. By using more observatons at each end of the run we are diminishing the effects of the non-cumulative errors, and increasing the effects of the cumulative errors, in the resulting period. The "best approximation" to the true period over the run can therefore be obtained by using such a number of observations at each end of the run as to make the sum of the first and second quantities as small as possible, and the mean error of the "best approximation" is the square root of this sum. Accuracy is always gained by including more cycles in the run. For long-period variables, the chief contribution to the error of the "best approximation" comes as a rule from cumulative errors; and in consequence the "best approximation" is usually obtained by using two, or perhaps three, observations at each end of the run.

Returning to RR Scorpii, we have a run of 53 cycles from $N=61$ to $N=114$, with $e=6^d.4$, $s=4^d.5$. The most accurate result corresponds to the use of three dates at each end, for which the sum of the two contributions to the (mean error)^2 is 0.41 (days)^2. The mean error is thus $0^d.64$. The best approximation is found thus:

N	T	N	T	ΔN	ΔT	P
					^{d}	^{d}
61	2412431	112	2426710	51	14279	279.98
62	2412729	113	2426998	51	14269	279.78
63	2413010	114	2427290	51	14280	280.00
						$P' = 279.92$

in which table the fifth column contains the difference of the N's, the sixth the difference of the T's, and the last the difference between T's divided by the difference between N's. Finally, the average of the entries in the last column is P', the best approximation. We may say that the true period over this run was $279^d.92 \pm 0^d.64$ (m.e.), "m.e." standing for "mean error."

In like fashion, the true period over the earlier run from $N=0$ to $N=59$ is found (using two observations at each end) to be $278^d.84 \pm 0^d.60$ (m.e.). Do these values differ appreciably from each other? The answer is "no," for their difference is but $1^d.08$, while the mean error of the difference is the square root of $(0.64)^2+(0.60)^2$, or $0^d.88$. The ratio of the difference to its mean error is only 1.33, and hence the dif-

ference could easily have arisen from errors of sampling. In this fashion, by comparing two best approximations with each other, taking into account their mean errors, we can always determine whether or not their difference is significant; if it is significant, then the existence of change of true period is established. When the ratio exceeds 3, the difference is significant, for the probability that a ratio of 3 or more will arise from fluctuations of sampling is only 27 in 10,000. The chance of a ratio of 2.5 or more is .0124, and of 2.0 or more is .045. A ratio of 2.5 or more can be taken as probably significant, but we must not be satisfied with less than this, since we shall be dealing with material that has already been selected for study because of its large fluctuations.

There is thus no evidence of such real changes of period in RR Scorpii over these two intervals as were claimed by Lehnert and Guthnick[9], and we are justified in treating the true period as constant. We find as the best approximation to the true period over the entire run 0-114, using two dates at each end, the value $279^d.44 \pm 0^d.43$ (m.e.).

A comment is in order at this stage on the use of the method of least squares for finding periods and their mean errors. Mathematical investigations[10] have shown that when cumulative error is present in a variable star, the period obtained by the method of least squares is comparable in accuracy with, or slightly less accurate than, the "best approximation" found as above. The mean error of the resulting period, however, is considerably underestimated by the method of least squares; it is in fact too small by a factor proportional to the square root of the number of equations of condition. The resulting over-estimation of the accuracy of periods, found over successive runs by the method of least squares, has therefore led workers to attach too much importance to small differences between them, and to conclude that changes of period occurred where in fact there was nothing but the usual errors of sampling in the assortments of cycles that constituted successive runs.

A Simple Test for Changes of True Period

The difference between successive values of $O - C$ is equal, obviously, to the amount by which the intervening cycle exceeds in length the mean cycle. Such values have already been computed for RR Scorpii, and appear in the table. Plot these differences (called "residuals") against their epoch numbers, and a diagram is obtained consisting of a succession of dots, distributed irregularly about a horizontal axis, in case there is no change of true period. Any general tendency for the dots to ascend or descend with increasing epoch number is clear evidence of a "secular" change of true period, while pronounced sinuosities in the distribution, too great to be explained as statistical irregularities, are clear evidence of "sinuous" changes of true period. There is a statistical test to determine the limit below which irregularities must be regarded

[9] Lehnert and Guthnick, *Geschichte und Literatur des Lichtwechsels*, **2**, 77, 1920.
[10] Sterne, *Harvard Circular* 386, Section 6, 1934.

as fluctuations, when the matter cannot be decided by a mere inspection; and that is[11] to compute a series of best approximations over successive intervals, between which changes of period are suspected, and then to determine whether they differ from the general mean by more than 2.5 times their mean errors. If there are only a few successive intervals, then such great differences are evidence of the reality of the changes of period; but if there are many, the limiting ratio should be taken to be 3.0, in order to be on the safe side, rather than 2.5.

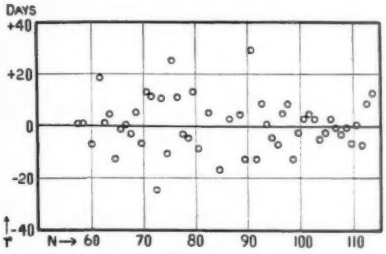


FIGURE 1

RESIDUALS OF THE CYCLES OF RR SCORPII, 1889-1933. PERIOD USED, $279^d.44$.

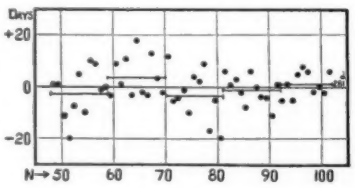


FIGURE 2.

RESIDUALS OF THE CYCLES OF T ANDROMEDAE, 1891-1933. PERIOD USED, 281^d.

In Figure 1 is shown the residual diagram of RR Scorpii from $N = 57$ to $N = 114$; there is clearly no evidence of any change of period, the dots being distributed in a purely random fashion about the horizontal axis. Only a few dots could have been inserted before $N = 57$, owing to the incompleteness of the data; but we have already tested for differences between the periods before and after $N = 61$, without finding any evidence of change. The conclusion is that no changes of true period of any sort are shown by RR Scorpii. In Figure 2 we show the residuals of the cycles of T Andromedae from a mean of 281^d. The data are given in reference 4. The short horizontal lines are the best approximations over the suspected intervals, and their values

Interval	Period (days)
48 - 59	278.91 ± 2.54
59 - 70	284.82 ± 2.54
70 - 81	277.82 ± 2.54
81 - 92	279.91 ± 2.54
92 - 102	282.20 ± 2.66

cannot be regarded as showing any change of true period. Figure 2 is a good example[12] of what is allowable in the way of statistical irregularities.

[11] The writer will publish elsewhere the details of an even simpler test depending upon the correlation between the best approximations over consecutive runs. It involves the statistics of very small samples, but is easy and rigorous in practice.

[12] G. Müller has reported a "change of period" for this star (*Geschichte u. Lit.....*, **1**, 10, 1918).

Methods for preparing "weighted" points in the residual diagram, to cover the intervals in which observations are lacking, are described in reference 4.

The Prediction of Dates of Maximum

Once e and s have been found, it is possible to compute the mean error of a predicted date of maximum. Suppose that the last observed date of maximum is T_0, and that one predicts the date of the p'th maximum following it by an extrapolation $T_0 + pP'$, where P' is the best approximation to the period. In short extrapolations, most of the uncertainty of prediction arises from non-cumulative error; in moderate extrapolations, from cumulative error; and in long extrapolations, from the error of the adopted value of the period. The predicted dates of maximum of RR Scorpii are J.D. $2427290 + 279^d.44\,p$, and the next maximum after the date of writing is predicted to occur on J.D. 2427849. The mean error of this prediction can be computed by the rule for combined errors, and is found to be $11^d.3$. There are thus 68 chances out of 100 that the next maximum will occur within one mean error of this date, or between February 4 and February 26, 1935; and 95 chances out of 100 that it will occur within two mean errors of this date, or between January 23 and March 10, 1935. These are fairly narrow limits. After 2163 A.D., however, the mean error of the dates predicted by the above formula will have increased to nearly 140^d, or half a cycle.

The Random Nature of $O - C$ Curves. Dice

We have already mentioned that $O - C$ diagrams are influenced by cumulative errors. After the lapse of sufficient time, they should indeed be expected to indicate practically nothing but the sum of the cumulative errors of the preceding cycles. The reader will see that the differences between successive values of $O - C$ for RR Scorpii, already listed, and plotted in Figure 1, fluctuate with a certain dispersion about the mean value zero. The value of $O - C$ at any date of maximum after the first is of course equal to $O - C$ for the first date, increased by the sum of the differences as far as the date in question. The sum of quantities that are distributed in a random fashion increases and diminishes erratically as more and more quantities are included in the sum, and its standard deviation equals the square root of the product of the number of quantities into the square of their standard deviation, by the rule for combining errors. Diagrams of $O - C$ behave in precisely this fashion, fluctuating irregularly this way and that, even in the complete absence of any change of true period; and for this reason they have been particularly liable to misinterpretation, as indicating changes of period, even when no changes of period have been present.

In Figure 3 is shown the $O - C$ diagram of RR Scorpii, computed with the period that makes $O - C$ vanish at the ends. It can be shown that apart from the effects of possible changes of period, somewhat

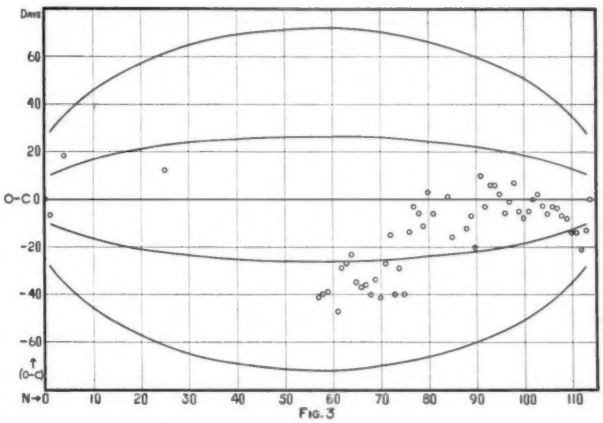


FIG. 3

RR SCORPII, 1846-1933. DIAGRAM OF $O - C$ FOR J. D. OF MAXIMUM.
C = J. D. 2395431 + 279^d.465 N.

more than one-half the points should lie within the smaller, and all but one or two points within the larger, ellipse; this is in fact the case. In Figure 4 is shown the $O - C$ diagram of T Andromedae, in which the ellipses have similar meanings. Unlike the ellipses for RR Scorpii, those for T Andromedae are complete at the ends because of the smallness of the non-cumulative error. For this star, e is nearly 0, while s is 8^d.4.

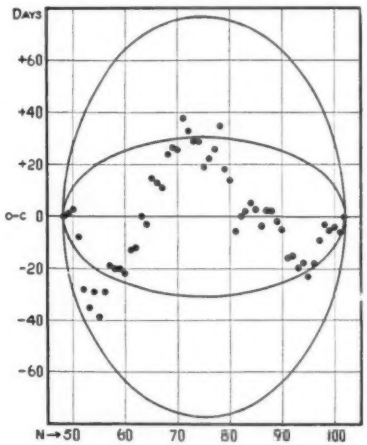


FIGURE 4.
T ANDROMEDAE, 1891-1933.
DIAGRAM OF $O - C$ FOR J. D. OF MAXIMUM.
C = J. D. 2412074 + 280^d.70 (N — 48).

There is experimental verification for the statement that the summation of purely random residuals is itself capable, without changes of period, to give rise to precisely the same sort of erratic behavior that is observed in most $O - C$ diagrams. Let us add together a set of artificial residuals having a mean value zero and a standard deviation equal to that of T Andromedae. One can prove that the sum of the dots on the top faces of a set of three dice is 10.5, with a standard deviation of

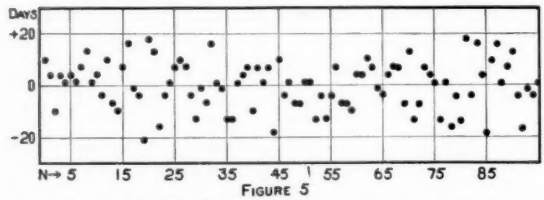


FIGURE 5

A SET OF SIMULATED "RESIDUALS OF THE CYCLES OF T ANDROMEDAE," OBTAINED BY DICE-THROWS, TO BE COMPARED WITH FIGURE 2.

2.96. After a fair toss of the dice, we obtain a residual by subtracting 10.5 from the sum and multiplying by the factor $2^d.84$ ($=8^d.4/2.96$). By repeated tosses we obtain a set of random residuals with the same standard deviation as those of the cycles of T Andromedae. In Figure 5 we show the random residuals, and in Figure 6 their sum, plotted against the "epoch number" or throw, N. Each sum is taken over the residuals shown in Figure 5, starting with the first throw and ending with the

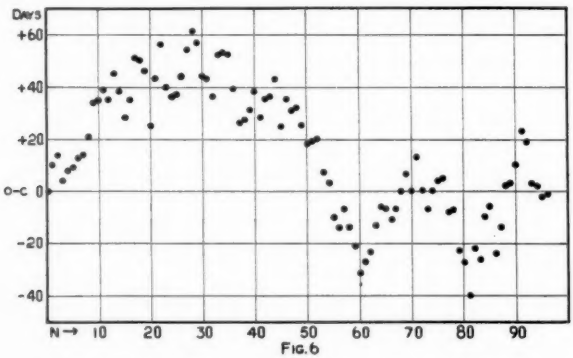


FIG. 6

A SIMULATED DIAGRAM OF "$O - C$ OF T ANDROMEDAE," OBTAINED BY SUMMATION OF THE RESIDUALS OF FIGURE 5, AND TO BE COMPARED WITH FIGURE 4.

N'th. The resemblance between the general natures of the irregularities in Figures 4 and 6 is striking; agreement in detail should of course not be expected. Using the factor appropriate to the s for RR Scorpii, and a different set of throws of three dice each, we obtained a diagram like Figure 3, but the resemblance was made still more striking by add-

ing to each of the artificial $O - C$ points so obtained, a "non-cumulative" error obtained by a new toss of three dice with a factor corresponding to the e of RR Scorpii. The results are shown in Figure 7, in which those $O - C$ points were omitted that corresponded to missing observations of RR Scorpii. Artificial $O - C$ diagrams even more "natural" in appearance than these have been obtained by the drawing of playing-cards from a well-shuffled deck, or by the counting of "heads" in a box of well-shaken coins.

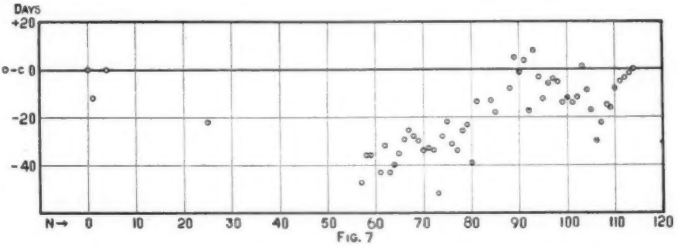


FIG. 7

A SIMULATED DIAGRAM OF "$O - C$ OF RR SCORPII," OBTAINED BY DICE-THROWS, TO BE COMPARED WITH FIGURE 3.

In erratic $O - C$ diagrams we have direct evidence of the existence of cumulative errors in the periods of variable stars, rather than of changes of period. In the present state of our knowledge it is futile to fit these fluctuations with "sine terms," or other mathematical formulae; for the irregularities are governed for the most part by the mere vagaries of Chance.

THE HARVARD COLLEGE OBSERVATORY, AUGUST 8, 1934.

Planet Notes for January, 1935

By CLIFFORD E. SMITH

Note: All times, unless stated otherwise, refer to Central Standard Time

The *Sun* will be moving with an apparent northeasterly motion from the central part of Sagittarius to the central part of Capricornus. On January 2 at 2:00 A.M., the earth will be at its perihelion point. On January 5 there will be a partial eclipse of the sun, visible in the southern Indian Ocean. The distance from the earth to the sun will be about 91.35 million miles on January 1, and this distance will increase about 180,000 miles during this period. The position of the sun on the first and last days of the month will be, respectively: R.A. $18^h\,42^m$, Decl. $-23°\,6'$; R.A. $20^h\,51^m$, Decl. $-17°\,42'$.

The phenomena of the *Moon* will occur as follows:

New Moon	Jan.	4 at 11 P.M.
First Quarter		11 " 3 P.M.
Full Moon		19 " 10 A.M.
Last Quarter		27 " 2 P.M.
Perigee		6 " 6 A.M.
Apogee		21 " 4 P.M.

There will be a total eclipse of the moon on January 19 which will be visible "generally in eastern Europe, Asia, Australia, the eastern part of the Indian Ocean, the Pacific Ocean, and western North America";[1] and the ending will be visible "generally in Europe, Africa except extreme western part, the Indian Ocean, Australia, the western part of the Pacific Ocean, and the extreme northwestern part of North America."[1]

Mercury, at the beginning of the month, will be near the sun in apparent position, but by the end of the month it will follow the sun by about an hour. At the end of the month Mercury will be in western Aquarius. Its position on January 31 will be R.A. $22^h\ 2^m$, Decl. $-12°\ 9'$, and its distance from the earth and its apparent diameter will be, respectively, about 95 million miles and about 17.4 seconds of arc. It will be in conjunction with Venus on January 26 at 11:00 A.M. (Mercury 38′ N), and it will be in conjunction with Saturn on January 31 at 3:00 A.M. (Mercury 1°.4 N).

Venus will be near Mercury in apparent position. Its distance from the earth will be about 150 million miles, and its apparent diameter will be slightly greater than 10 seconds of arc. On January 31 at 6:00 A.M. there will be a rather close conjunction with Saturn, Venus being about 10 minutes of arc south (about a third the diameter of the moon). At that time the apparent motion of Venus in the sky will be about 1½ degrees per day.

Mars will be in the morning sky in central Virgo. During the middle of the month it will rise about 11:00 P.M., local standard time. Its distance from the earth will decrease from about 125 million to about 98 million miles, and its apparent diameter will increase from about 7 to about 9 seconds of arc. It will be in conjunction with the moon on January 26 at 10:00 A.M. (Mars 8°.4 N).

Jupiter will be a morning object in central Libra. During the middle of the month it will rise about 2:00 A.M., local time, for moderately northern latitudes and earlier for more southerly latitudes. Its distance from the earth will be about 540 million miles, and its apparent diameter will be about 32 seconds of arc. Jupiter will be in conjunction with the moon on January 1 at 3:00 A.M. and on January 28 at 7:00 P.M. (Jupiter 6°.3 N).

Saturn will be an early evening object in eastern Capricornus. During the middle of the month it will set about two hours after the sun. Its distance from the earth will be about 980 million miles, and its apparent diameter will be about 14 seconds of arc. Conjunction with the moon will occur on January 7 at 8:00 P.M. (Saturn 3°.9 S). A conjunction with Mercury will occur on January 31 at 3:00 A.M. (Saturn 1°.4 S), and a rather close conjunction with Venus three hours later (Saturn 10′ N).

Uranus will be an evening object in eastern Pisces about 2 degrees north of the star Σ 155. On January 18 at 8:00 A.M. it will be at quadrature east, and so, during the middle of the month it will set about midnight, local time. Its distance from the earth will be about 1840 million miles, and its apparent diameter will be about 3½ seconds of arc. Conjunction with the moon will occur on January 12 at 7:00 A.M. (Uranus 6°.2 S). Its position on January 14 will be R.A. $1^h\ 43^m$, Decl. $+10°\ 6'$.

Neptune will continue in southern Leo about a degree southeast of χ Leonis. During the middle of the month it will rise about 9:00 P.M., local time. Its distance from the earth will be about 2750 million miles, and its apparent diameter will be

[1] *American Ephemeris and Nautical Almanac*, 1935, p. 580.

about 2½ seconds of arc. Conjunction with the moon will occur on January 23 at 10:00 A.M. (Neptune 5?1 N). Its position on January 14 will be R.A. $11^h\ 4^m$, Decl. $+7°\ 2'$.

Variable Stars

Monthly Report of the American Association of Variable Star Observers for October, 1934

The twenty-third annual meeting of the Association was held at the Harvard Observatory on October 19 and 20 with a total attendance of sixty-five. On Friday evening members and their friends were guests of the Bond Astronomical Club, at which meeting Dr. Frank Schlesinger addressed those assembled on "The International Astronomical Union," stressing in particular its past history and its purposes.

Newly elected members to the Council are Miss Margaret Harwood, of Nantucket, Massachusetts, and Rev. T. C. H. Bouton, of St. Petersburg, Florida. Messrs. Jones and Peltier were re-elected to the Council. This was the first time for many years that the members were given an opportunity to vote on a list containing more candidates than were to be elected. It evidently proved quite satisfactory. The officers of last year were re-elected as follows: Ernest W. Brown, President, Harlow Shapley, first Vice-President, Charles W. Elmer, second Vice-President, William Tyler Olcott, Secretary, Percy W. Witherell, Treasurer, and Leon Campbell, Recorder.

Dr. Raymond S. Dugan, our guest of the meeting, was elected to Honorary Membership. He addressed the Association at length on "Eclipsing Variables," stressing the need for observations at least once a year to note corrections to the period.

Mr. Leslie C. Peltier attended his first meeting at Cambridge and was the recipient of the Association's first Merit Award, consisting of a cash prize together with a suitably inscribed parchment. This prize was made possible through the generosity of several life and sustaining members of the Association.

Recent observations—not included in this report—indicate the gradual decline in brightness of R Coronae Borealis after a maximum at sixth magnitude lasting approximately ten years. At the present writing the variable is approximately of the eighth magnitude. It may or may not decrease to fourteenth magnitude, so it behooves us to keep a close watch on the star. Unfortunately it is rather poorly placed for observations, except early in the evening or very late in the morning.

The appended annual report is most gratifying to all concerned. One hundred and forty-one observers have contributed observations, from only one by several sporadic observers, to 4778 by Jones. Peltier came second with 2801, and Houghton, third with 2214. Particular attention is called to the coöperative work of the astronomical group at Milwaukee, Wisconsin, under the guidance of Mr. L. Armfield; more than 4300 observations having been communicated by a dozen observers.

With a total of more than 43,000 observations for the year, on nearly 450 variables, by observers located in nearly every latitude and longitude over the earth, we have just cause to be proud of nearly one-half million observations made in the past twenty-three years. Slowly, but surely, the A.A.V.S.O. observers are accumulating data of increasing value to astronomers of the present and future.

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

Aug. 0 = J.D. 2427650; Sept. 0 = J.D. 2427681; Oct. 0 = J.D. 2427711.

J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

V SCL
000339
672 11.8 Bl
S SCL
001032
652 9.0 Ht
665 8.9 Ht
669 8.8 Ht
672 8.7 Bl
678 8.9 Ht
682 8.8 Ht
688 8.6 Ht
689 8.0 Dk
694 8.1 Dk
697 7.9 Ht
705 7.7 Dk
719 6.5 Kd
X AND
001046
718[13.8 Ie
T CET
001620
695 5.9 Lt
706 5.8 Lt
710 5.9 Lt
719 6.3 Kd
T AND
001726
712 12.4 Hf
712 12.6 Wd
713 12.0 So
716 12.2 Pt
718 11.6 Gy
724 11.5 Es
727 11.4 Gy
T CAS
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683 8.3 Ah
686 8.2 Mn
689 8.1 Ah
690 8.1 Sq
691 8.2 Ah
691 8.2 Pk
692 7.9 Jo
693 8.2 Ah
694 8.2 Ah
694 8.8 Sx
694 7.9 Ra
695 8.0 Ah
696 8.1 Ah
696 8.0 Hz
697 8.0 Ah
698 8.5 Fi
698 8.5 Wd
698 8.7 Wp
699 7.7 Hf
701 8.0 Sh

T CAS
001755
703 8.2 Ah
705 8.5 Pb
705 8.5 Hk
706 8.3 Ah
706 8.6 Wd
706 8.0 Jo
707 8.4 Hf
708 8.6 Pb
708 8.6 Hk
708 8.4 Wd
709 8.3 Ah
709 8.0 Hz
709 8.9 Sx
709 8.3 Mn
710 8.3 Ah
711 8.7 Fi
711 8.1 Pb
711 8.4 My
711 8.8 Wp
712 8.0 Jo
713 8.6 Mw
714 8.3 Dl
715 8.2 Jo
716 8.5 Pt
717 8.4 My
717 8.9 Gy
718 8.9 Gy
718 8.7 Hf
719 8.6 Dl
719 8.6 Hm
720 9.2 Mw
720 8.7 Wd
721 8.3 Fm
721 8.6 So
722 8.7 My
723 8.5 Dl
727 7.9 Wh
727 8.9 Gy
R AND
001838
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691 10.6 Kp
692 11.1 Jo
694 10.4 Ra
696 10.4 Ah
699 11.3 Cm
700 11.1 Hf
700 11.2 Wd
714 11.4 Cm
714 11.6 So
716 11.5 Pt
720 11.7 Wd
723 11.9 Ma
724 11.6 Es
S TUC
001862
665 10.9 Ht

S TUC
001862
669 10.3 Ht
672 10.3 Bl
678 9.6 Ht
682 9.4 Ht
684 9.2 En
688 9.5 Ht
697 9.6 Ht
S CET
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720[12.5 Mw
T PHE
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652[13.0 Ht
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688[13.0 Ht
W SCL
002833
672[12.8 Bl
Y CEP
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694 12.5 Ra
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712 11.8 Wd
712 11.8 Hf
713 12.0 Jo
715 11.9 Jo
716 11.8 Pt
716 11.3 Es
719 11.2 Kn
720 11.0 Je
721 11.0 Es
RW AND
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713 12.5 So
716 12.3 Pt
717 12.7 Gy
717 12.6 My
718 12.8 Ie
720 13.2 Wd
722 13.0 My
V AND
004435
713 14.4 So
X SCL
004435
672[12.6 Bl
RR AND
004533
692 9.2 Jo

RR AND
004533
706 9.7 Jo
712 10.0 Jo
713 10.6 So
715 10.5 Jo
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687 9.5 Hu
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692 9.6 Jo
696 9.7 Ar
696 9.7 Pb
697 9.6 Ar
703 9.6 Ar
703 9.6 Pb
706 9.5 Jo
711 9.6 Ar
711 9.6 Pb
712 9.6 Jo
716 10.4 Pt
717 10.1 Gy
718 10.1 Sf
718 9.3 Jo
727 10.3 Gy
— CAS
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685 10.8 Lf
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687 10.8 Ar
687 10.7 Hu
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692 10.7 Jo
696 10.9 Ar
696 10.8 Pb
697 10.8 Ar
703 10.7 Ar
703 10.6 Pb
706 10.5 Jo
711 10.6 Ar
711 10.6 Pb
712 10.4 Jo
716 10.9 Pt
718 10.2 Jo
W CAS
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685 10.1 Ar
685 10.1 Hk
687 9.6 Fr
687 9.7 Gw
687 9.7 Af
689 10.2 Fr

W CAS
004958
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692 9.6 Jo
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697 10.6 Dh
697 10.4 Af
697 10.4 Pb
697 10.6 Hk
698 10.5 Pb
698 10.4 Ko
698 10.4 Af
698 10.4 Gw
698 10.3 Fr
700 10.5 Hf
700 10.5 Sc
700 10.5 Wd
700 10.6 Pb
703 10.7 Pb
705 10.8 Hk
705 10.8 Pb
706 10.4 Fr
706 9.9 Gw
706 9.9 Jo
706 10.5 Pb
708 10.5 Fr
708 9.9 Gw
708 10.4 Af
708 10.5 Wd
708 10.6 Pb
709 11.1 BL
711 10.7 Fr
711 10.4 Gw
711 10.8 Ar
711 10.8 Pb
711 10.7 Hk
711 10.3 My
712 9.8 Jo
712 11.4 BL
712 10.9 Cm
713 11.5 BL
715 11.2 Hf
715 9.8 Jo
716 11.2 Pt
717 10.5 My
718 11.6 BL
721 10.7 So
722 10.5 My
724 11.4 BL
U TUC
005475
685 9.7 Lf
685 9.7 Ar
685 9.5 Ar
685 9.5 Hu
685 9.7 Pb
685 9.6 Jo
686 10.4 Pt
687 10.1 Gy
687 10.1 Sf
687 10.8 Ar
687 10.8 Ar
687 10.7 Hu
688 10.8 Ar
688 10.8 Lf
688 10.4 Pf
689 10.6 So
689 10.6 Jo
689 10.4 Lf
689 10.6 Pb
689 10.4 Pf
690 10.5 Jo
690 10.5 Pt
691 10.5 Jo
691 10.6 Ar
691 10.6 Pb
692 10.4 Jo
692 10.2 Jo
U TUC
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692 10.2 Fr

U TUC
005475
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697 10.1 Ht
U SCL
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U AND
010940
710 12.0 Jo
718 10.7 Jo
718 10.9 Gy
718 11.2 Ie
727 10.3 Gy
UZ AND
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714[13.1 So
723[15.0 Ma
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011208
714[13.0 Mw
S CAS
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U PSC
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716[12.3 Pt
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RZ PER
012350
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707 9.5 Jo
712 9.8 Jo
713 9.7 Jo
714 9.8 Jo
717 10.0 Gy
718 9.9 Gy
718 9.7 Jo
718 10.8 Wp
721 10.0 Gy
727 9.7 Gy
R PSC
012502
692 8.6 Ah
692 8.5 Jo
693 8.7 Ah
694 8.7 Ah
696 8.8 Ah
696 8.9 Cl
696 8.5 Hz
697 8.8 Hk
697 8.8 Hu
699 8.7 Hf
710 9.2 Ah
712 9.0 Jo

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
R PSC			**U PER**			**R ARI**			**T PER**			**S PER**			**R CET**		
012502			015254			021024			012258			021558			*022000*		
715	9.0	Jo	716	9.4	Pt	714	10.0	Fm	713	9.1	Ru	699	9.6	Hf	720	9.5	Dl
715	9.3	Hf	717	9.4	Ba	715	10.5	Jo	715	8.7	Jo	701	9.4	Lu	720	9.6	Cy
716	9.2	Pt	717	9.8	Ru	715	10.3	Hf	715	9.2	Hf	706	9.6	Lu	720	9.8	Mw
718	9.6	Gy	717	9.5	My	716	10.3	Pt	716	8.9	Pt	706	9.2	Sz	722	9.8	My
727	10.2	Gy	718	8.6	Mc	723	11.4	Ma	717	9.0	Ru	707	9.2	Jo	**RR PER**		
RU AND			718	9.6	Jo	**W AND**			718	8.9	Cm	708	9.3	Wd	022150		
013238			718	9.7	Hf	021143a			**Z CEP**			708	9.3	Pb	721	13.5	So
716	11.2	Pt	718	9.8	BL	683	7.9	Ah	021281			708	9.3	Hk	**R FOR**		
717	11.5	Gy	719	9.8	Kn	686	7.9	Ko	716	13.2	Pt	709	9.4	BL	*022426*		
718	11.3	Ie	720	9.9	Rc	689	8.0	Ah	**o CET**			709	9.5	Cm	672	9.9	Bl
721	11.6	So	721	10.0	So	691	7.9	Ah	*021403*			709	9.4	Dl	**U CET**		
723	11.3	Ma	722	9.7	My	692	7.9	Ah	685	8.6	Si	709	9.4	Sx	*022813*		
727	11.2	Gy	722	8.8	Mc	692	7.8	Jo	689	8.8	Cy	709	9.6	Lu	716	12.6	Pt
Y AND			722	10.0	Cy	693	8.0	Ah	692	9.2	Ah	709	9.7	Kg	**RR CEP**		
013338			724	10.1	BL	693	8.0	Hf	692	9.0	Sc	709	9.4	Hm	022980		
721	13.1	So	724	9.5	Ba	694	8.1	Ah	692	8.7	Jo	711	9.3	Pk	716	12.9	Pt
723	13.5	Ma	**XX PER**			694	7.6	Jo	693	9.2	Ah	711	9.3	Ru	**R TRI**		
X CAS			015654			694	7.5	Ra	694	9.2	Ah	711	9.1	My	023133		
014958			691	8.3	Lt	695	8.0	Ah	696	9.2	Ah	711	9.5	Sq	683	9.5	Ah
684	12.5	Bn	711	8.4	Lt	696	8.0	Ah	697	8.9	Sc	712	9.5	BL	689	9.5	Ah
690	12.4	Bn	**R ARI**			697	8.0	Ah	697	8.9	Pb	712	9.0	Jo	692	9.7	Ah
692	12.3	Jo	021024			699	7.8	Hf	699	8.9	Hf	713	9.6	BL	694	9.9	Ah
711	12.1	Wu	683	8.6	Ah	700	7.8	Ah	708	8.5	Fr	713	9.3	Dl	695	9.7	Sx
716	12.2	Pt	689	8.9	Ah	707	8.0	Jo	708	8.9	Wd	713	9.3	Hm	696	9.8	Ah
718	12.5	Jo	692	9.2	Ah	709	8.4	Ah	708	8.6	Af	713	9.2	Ru	697	9.9	Hu
721	12.0	So	692	9.6	Jo	709	8.1	Hf	708	8.6	Pb	715	9.1	Cm	697	10.0	Hk
723	12.3	Bn	693	9.3	Ah	709	8.0	Sh	708	8.5	Hk	715	9.5	Hf	699	9.6	Hf
U PER			694	9.5	Ah	710	8.5	Ah	709	9.1	Sx	715	8.9	Jo	700	9.8	Wd
015254			695	9.3	Ah	712	8.2	Jo	712	8.4	Jo	716	9.0	Pt	708	10.0	Je
682	8.6	Ry	695	8.6	Sx	714	8.4	BH	713	8.6	Mw	717	9.3	Ru	709	10.5	Kg
683	8.7	Sq	696	9.3	Ah	715	8.3	Jo	713	8.6	BL	717	8.9	My	709	10.4	Jo
687	8.6	Ry	696	9.6	Hz	716	8.0	Pt	714	8.8	Mw	718	9.6	BL	709	10.5	Sx
692	8.8	Jo	697	9.6	Ah	717	8.6	Gy	715	8.6	Jo	718	9.7	Cm	710	10.7	Ah
692	8.5	Ry	697	9.8	Fr	718	8.3	Hf	715	8.7	Hf	718	9.6	Kg	712	10.3	Jo
695	8.6	Ry	697	9.8	Pb	718	8.9	Wd	716	8.4	Pt	719	9.6	Kg	714	9.3	Mw
699	9.1	Hf	697	9.9	Hk	720	8.4	Kn	718	8.5	Jo	719	9.7	Cm	714	10.6	BH
700	9.2	Ry	697	9.5	Hu	727	8.8	Gy	718	8.6	BL	720	9.3	Gy	715	9.5	Hf
702	9.3	Ry	698	9.7	Pb	**T PER**			718	8.9	Dl	721	9.3	So	715	10.4	Jo
703	10.6	Pb	698	9.7	Fr	021258			718	8.9	Wd	722	9.2	My	716	11.0	Pt
707	9.0	Jo	698	9.8	Sc	679	9.4	Hr	718	8.8	Sf	723	9.3	Dl	717	11.4	Gy
708	9.9	Pb	699	9.5	Hf	683	9.0	Sq	719	8.6	Cy	724	9.5	BL	718	11.3	Wd
708	9.8	Hk	700	10.0	Pb	692	8.8	Jo	720	8.9	Dl	727	9.3	Gy	718	11.3	Sf
708	9.4	Ry	700	9.5	Wd	695	9.0	Sx	720	8.5	Mw	**R CET**			723	11.4	Ma
709	9.4	BL	703	9.7	Pb	698	9.3	Lt	721	8.5	Mw	*022000*			727	11.3	Gy
709	9.7	Hf	703	9.7	Hk	699	9.2	Wd	721	8.2	Cy	692	7.7	Jo	**T ARI**		
709	9.5	Sh	705	9.9	Pb	699	9.2	Hf	723	8.6	Ma	696	8.0	Hz	024217		
710	9.8	Rc	706	10.0	Pb	701	9.4	Lu	724	8.4	BL	697	8.4	Hk	692	9.9	Jo
710	9.4	Ry	708	10.0	Pb	706	9.5	Lu	**S PER**			699	8.1	Hf	694	10.0	Jo
711	9.2	My	708	10.1	Hk	707	8.9	Jo	021558			708	8.4	Wd	697	11.3	Hu
711	9.8	Sq	708	10.2	Fr	708	9.1	Pb	679	10.1	Hr	711	8.9	My	697	11.0	Hk
711	9.6	Ru	708	10.2	Af	708	9.1	Hk	683	9.3	Sq	712	8.9	Jo	697	10.7	Pb
712	9.7	BL	709	10.0	Jo	708	9.2	Wd	685	9.3	Pk	714	9.4	Mw	698	10.9	Pb
712	9.3	Jo	709	10.3	Sx	709	9.1	Sx	686	9.6	Cy	715	9.4	Jo	698	10.9	Fr
712	8.7	Mc	710	10.1	Ah	709	9.6	Lu	691	9.7	Cy	715	9.3	Hf	700	10.8	Pb
713	9.6	Ba	711	10.4	Fr	709	9.4	Kg	692	9.2	Jo	716	9.6	Hz	703	10.9	Pb
713	9.9	BL	711	10.4	Ar	711	9.0	Ru	695	9.6	Sx	717	9.2	My	703	10.9	Hk
713	8.9	Ru	711	10.3	Pb	711	9.2	Sq	699	9.3	Dl	718	9.4	Dl	705	11.0	Pb
715	9.4	Jo	712	10.4	Jo	712	9.0	Jo	699	9.3	Wd	718	9.3	Wd	706	10.6	Pb

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T ARI	W PER	Y PER	U CAM	S TAU	R DOR
024217	024356	032043	033362	042309	*043562*
707 10.0 Jo	713 10.3 Mc	693 10.6 Ah	719 8.2 Cy	687 10.4 Hu	688 5.1 Ht
708 10.9 Fr	713 9.8 Ru	694 10.4 Ah	720 8.0 Cy	689 10.8 Ar	R CAE
708 11.0 Hk	715 9.8 Hf	695 10.5 Ah	721 8.2 Cy	696 10.7 Ar	*043738*
708 10.9 Pb	716 10.1 Pt	696 10.4 Ah	X PER	705 10.1 Hk	683 11.9 Ht
711 10.9 Pb	717 10.2 My	697 10.4 Ah	034930	705 10.1 Pb	R PIC
711 10.9 Ar	718 10.3 Wp	700 10.3 Hf	698 6.4 Lt	711 10.5 Ar	*044349*
711 10.9 Fr	718 10.2 Mc	700 10.4 Wd	710 6.4 Lt	711 10.5 Pb	672 7.4 Bl
711 10.8 Dh	721 10.3 Mc	708 10.2 Fr	712 6.7 Mc	716 10.1 Pt	683 7.9 Ht
W PER	721 10.0 So	708 10.2 Af	713 6.6 Mc	718 10.6 Gy	V TAU
024356	722 10.0 My	708 10.2 Hk	718 6.3 Mc	722 10.7 Cy	044617
682 10.2 Ry	722 10.2 Cy	708 10.1 Pb	720 6.3 Mc	723 11.5 Ma	696 12.9 Ar
685 10.1 Fr	723 10.3 Mc	709 10.0 BL	721 6.2 Mc	727 11.0 Gy	697 12.6 Hk
685 9.7 Af	R HOR	709 10.3 Jo	724 6.5 Mc	T CAM	711 13.3 Ar
685 10.0 Ar	*025050*	710 10.4 Ah	R TAU	043065	727 13.1 Gy
685 10.0 Hk	669 5.6 Ht	711 10.3 Pk	042209	686 8.4 Ko	AB AUR
687 9.5 Fr	672 5.9 Bl	711 10.1 Mc	687 14.0 Hu	692 8.5 Jo	044930
687 9.9 Af	682 5.6 Ht	711 10.2 Ar	689 13.6 Ar	698 8.3 Ko	698 7.0 Lt
687 9.9 Ar	688 5.8 Ht	711 10.2 Pb	696 13.7 Ar	699 8.8 Hf	710 7.0 Lt
687 10.0 Hk	697 6.0 Ht	712 10.4 Jo	711 14.1 Ar	706 7.9 Jo	R LEP
687 10.2 Ry	T HOR	712 9.9 BL	723 13.8 Ma	712 8.2 Jo	*045514*
689 10.0 Fr	*025751*	713 10.1 BL	W TAU	713 8.3 BL	692 6.3 Jo
689 9.9 Dh	669 10.5 Ht	713 10.2 Mc	042215	714 8.7 Fm	712 5.9 Jo
690 9.9 Pb	672 10.4 Bl	715 9.9 Jo	687 10.2 Sc	715 8.6 Hf	717 6.1 Pt
693 10.0 Pb	682 11.6 Ht	716 10.2 Pt	687 10.2 Tr	716 8.4 Hz	718 6.0 Jo
693 10.1 Ar	688 12.3 Ht	718 10.1 Mc	687 10.2 Ar	717 8.0 Pt	718 7.3 Gy
693 10.0 Ry	U ARI	718 10.0 BL	687 10.2 Hu	718 8.0 Jo	723 6.6 Ma
695 10.0 Sx	030514	720 10.2 Kn	689 10.5 Dh	718 8.2 BL	727 7.8 Gy
695 10.2 Ry	697 10.2 Sc	721 10.0 Mc	689 10.5 Ar	724 8.2 BL	V ORI
697 10.3 Fr	697 10.2 Pb	723 10.0 Mc	692 10.5 Jo	RX TAU	050003
697 10.3 Af	697 10.4 Hk	724 10.0 BL	696 10.3 Dh	043208	717 13.5 Pt
697 10.3 Pb	711 11.0 My	727 9.8 Wh	696 10.4 Sc	697 13.1 Hu	T LEP
698 10.3 Fr	715 10.6 Jo	R PER	696 10.3 Ar	711 14.2 Ar	*050022*
698 10.4 Af	717 11.2 My	032335	697 10.4 Sc	R RET	717 12.3 Pt
698 10.4 Pb	722 12.2 My	692 9.8 Jo	697 10.4 Hk	*043263*	S PIC
699 9.7 Hf	727 12.2 Gy	694 9.6 Jo	697 10.7 Hu	672 12.2 Bl	*050848*
700 9.9 Sc	X CET	699 9.2 Hf	703 10.3 Pb	688 12.3 Ht	683 8.7 Ht
700 9.9 Ar	*031401*	700 9.1 Wd	703 10.2 Hk	X CAM	672 8.5 Bl
700 9.8 Pb	692 9.7 Jo	709 9.1 Sx	703 10.2 Ar	043274	R AUR
700 10.0 Ry	709 9.2 Sx	711 9.1 My	705 10.2 Pb	692 7.6 Jo	050953
702 10.0 Ry	711 9.0 My	712 9.1 Kn	705 10.1 Hk	699 7.8 Hf	687 10.4 Hk
703 9.7 Pb	712 9.6 Jo	712 9.4 Jo	707 10.2 Md	706 7.7 Jo	696 10.3 Hk
705 10.1 Pb	716 9.2 Pt	715 9.3 Jo	708 10.6 Hk	708 8.0 Kn	696 10.6 Dh
705 10.2 Hk	717 9.1 My	716 9.2 Pt	708 10.5 Pb	711 7.8 My	697 10.6 Sc
706 10.5 Fr	717 9.6 Gy	717 9.3 My	708 10.6 Fr	712 7.8 Jo	697 10.5 Pb
708 10.3 Fr	718 9.3 Sf	722 9.3 My	708 10.5 Af	713 8.3 Cy	697 10.6 Hk
708 10.2 Af	718 9.7 Jo	723 9.2 Ma	709 10.4 Jo	715 8.3 Hf	703 10.7 Ar
708 10.3 Pb	719 9.4 BH	NOV PER	711 10.4 Fr	716 8.5 Hz	703 10.7 Pb
708 10.3 Hk	721 9.3 Hz	032443	711 10.3 Ar	717 8.4 My	705 10.8 Pb
708 10.1 Ry	722 9.3 My	716 12.4 Pt	711 10.3 Pb	717 8.3 Pt	705 10.6 Hk
709 9.6 Sh	727 9.4 Gy	721 12.3 So	711 10.2 My	718 8.0 Jo	708 11.6 Pb
709 10.0 Sx	Y PER	U CAM	713 10.2 Cy	722 8.7 My	708 11.7 Hk
710 10.0 Ry	032043	033362	716 10.2 Pt	722 8.7 Cy	711 11.8 Ar
711 10.2 Fr	683 9.8 Sq	692 7.5 Jo	717 10.7 Ba	R DOR	711 11.9 Pb
711 10.2 Dh	683 10.4 Ah	694 7.5 Jo	717 10.4 My	*043562*	717 12.8 Pt
711 10.3 Ar	689 10.4 Ah	712 7.7 Jo	718 10.4 Jo	672 5.6 Bl	718 11.9 Wd
711 10.3 Pb	691 10.2 Pk	712 8.0 Cy	722 10.2 My	683 5.1 Ht	T PIC
711 9.8 My	692 9.8 Jo	713 8.2 Cy	722 10.6 Cy		*051247*
712 10.3 Cy	692 10.3 Ah	718 7.5 Jo			672 9.5 Bl

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J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

T Pic
051247
683 10.3 Ht
Nov Tau
051316
696 13.6 Ar
T Col
051533
683 8.1 Ht
694 7.9 Dk
704 7.4 Dk
S Aur
052034
687 9.2 Hk
692 8.8 Jo
696 9.2 Hk
697 9.2 Hk
697 9.2 Pb
703 9.2 Pb
703 9.1 Hk
705 8.9 Hk
705 9.0 Pb
708 9.2 Pb
708 9.1 Hk
711 9.0 My
712 9.2 Gy
712 8.7 Jo
715 9.0 Gy
715 8.6 Jo
717 8.9 My
717 8.4 Pt
718 8.8 Jo
718 9.2 Gy
718 9.9 BL
722 8.8 My
724 9.6 Mc
724 9.5 BL
727 9.2 Gy
W Aur
052036
687[12.3 Hk
697[13.1 Hu
717[12.3 Pt
723 14.1 Ma
S Ori
052404
696 9.6 Hk
697 9.0 Hk
708 8.6 Hk
708 8.7 Pb
711 8.7 Hk
712 8.6 Jo
717 8.2 Pt
718 8.7 Jo
718 8.5 Gy
723 9.1 Ma
727 9.0 Gy
T Ori
053005a
687 10.1 Hu

T Ori
053005a
689 10.7 Fr
689 10.6 Dh
689 10.7 Ar
689 10.7 Pb
696 10.5 Pb
696 10.3 Hk
696 10.4 Dh
696 10.5 Ar
697 10.3 Sc
697 10.4 Pb
697 10.3 Hk
697 10.1 Hu
699 10.2 Ko
703 10.5 Pb
708 10.3 Pb
708 9.9 Hk
711 9.9 Pb
711 9.9 Hu
711 9.9 Fr
711 9.9 Ar
712 10.6 Jo
712 9.8 Cy
717 9.9 Pt
717 10.0 My
718 10.4 Jo
719 10.5 Cy
721 10.4 Cy
722 10.3 Cy
722 10.4 My
723 10.0 Ma
AN Ori
053005t
689 11.6 Ar
689 11.6 Pb
696 11.5 Pb
696 11.5 Dh
696 11.5 Ar
697 11.5 Pb
697 11.6 Hu
708 11.7 Pb
711 11.6 Pb
723 10.9 Ma
S Cam
053068
699 9.6 Hf
706 8.9 Jo
708 9.4 Kn
711 9.4 My
712 9.0 Jo
715 9.7 Hf
717 9.2 Pt
717 9.8 My
718 9.0 Jo
722 9.7 My
RR Tau
053326
686 10.6 Ry
687 11.0 Hk

RR Tau
053326
687 11.0 Hu
689 11.4 Fr
689 11.5 Ar
692 11.9 Ry
693 12.0 Ry
696 12.4 Ar
697 12.3 Hu
698 12.7 Ry
700 12.8 Ry
711 11.8 Ar
711 11.8 Pb
717 11.8 Pt
718 12.0 Gy
720 11.7 Gy
721 11.1 Gy
722 10.9 Cy
727 10.9 Gy
RU Aur
053337
687 11.8 Hk
687 12.0 Hu
696 12.5 Hk
711 12.2 My
717 12.2 My
722 12.8 My
U Aur
053531
692 8.9 Jo
697 9.3 Sc
697 9.4 Pb
697 9.5 Hk
712 8.7 Jo
715 8.8 Jo
717 10.2 Pt
718 10.2 Ie
SU Tau
054319
689 10.6 Fr
689 10.5 Ar
696 10.2 Ar
699 10.1 Ko
711 10.2 Ar
712 10.2 Cy
712 10.7 Gy
717 10.3 Pt
718 10.0 Gy
718 10.0 Ie
719 10.2 Cy
720 10.2 Gy
721 10.4 Gy
721 10.1 Cy
722 10.2 Cy
723 10.0 Ma
727 10.0 Gy
S Col
054331
683[12.6 Ht

Z Tau
054615a
696 12.7 Ar
718 12.7 Gy
723 13.0 Ma
RS Tau
054615b
720 9.9 Mc
696 9.0 Ar
718 9.0 Gy
727 9.5 Gy
RU Tau
054615c
727 9.8 Gy
R Oct
055686
648[12.0 Ht
660[12.1 Bl
665[12.0 Ht
680 11.6 Bl
681 11.5 En
683[12.4 Ht
α Ori
054907
697 0.9 Lt
U Ori
054920a
692 11.1 Jo
696 10.8 Hk
697 10.9 Hk
712 9.8 Jo
715 9.6 Jo
717 10.2 Pt
718 10.4 Gy
719 9.9 Kd
UW Ori
054920b
696 10.6 Hk
697 11.0 Hk
V Cam
054974
692 9.7 Jo
694 9.4 Jo
712 9.4 Jo
715 9.5 Jo
715 11.4 Gy
717 10.2 Pt
718 10.6 Gy
Z Aur
055353
712 9.7 Jo
715 9.9 Jo
694 10.5 Jo
711 10.1 Ar
711 10.1 Pb
712 10.4 Pt
712 9.7 Mc
712 10.3 Jo
712 9.7 Cy
712 9.7 Cy
715 9.9 Jo
715 9.9 Jo
717 10.4 Pt
718 9.9 Mc

Z Aur
055353
718 10.3 Gy
718 10.0 Jo
719 9.6 Cy
720 10.6 Gy
720 9.9 Mc
721 10.1 Mc
721 10.5 Pt
721 9.8 Gy
723 10.3 Mc
727 9.8 Gy
R Oct
055686
648[12.0 Ht
660[12.1 Bl
665[12.0 Ht
680 11.6 Bl
681 11.5 En
682 11.4 Ht
688 11.4 Ht
689 11.5 En
X Aur
060450
711 9.0 Ar
711 9.0 Pb
712 8.6 Jo
715 8.9 Jo
717 9.0 Pt
V Aur
061647
712 12.0 Jo
718 12.0 Gy
727 12.1 Gy
V Mon
061702
717 12.7 Pt
718 12.6 Ie
UU Aur
062938
688 5.5 Lt
697 5.5 Lt
710 5.5 Lt
U Lyn
063159
692 9.5 Jo
712 9.7 Jo
715 9.9 Jo
R Mon
063308
696 12.7 Ar
697 12.5 Hu
712 12.5 Jo
Nov Pic
063462
683 8.7 Ht
S Lyn
063558
682 12.4 Ry
687 12.2 Ry

S Lyn
063558
693 11.5 Ry
698 11.5 Ry
715 10.7 Jo
X Gem
064030
712 9.0 Jo
718 9.0 Jo
718 9.9 Gy
723 10.2 Cy
724 9.9 Ma
727 10.4 Gy
Y Mon
065111
717 10.3 Pt
718 10.7 Jo
724 9.6 Ma
X Mon
065208
718 8.6 Gy
727 8.3 Gy
R Lyn
065355
694 9.5 Ah
696 9.4 Ah
706 9.4 Ah
710 9.1 Ah
712 8.8 Jo
715 8.6 Jo
RS Gem
065530
718 11.9 Gy
720 12.0 Gy
727 12.0 Gy
V CMi
070109
697 8.5 Lt
717 7.0 Pt
718 7.8 Jo
718 8.0 Gy
727 7.2 Gy
R Gem
070122a
696[12.7 Hk
717[12.2 Pt
Z Gem
070122b
717 12.4 Pt
TW Gem
070122c
696 8.4 Hk
698 8.2 Lt
R CMi
070310
717 11.5 Pt
718 10.6 Jo
718 11.0 Gy
727 10.8 Gy

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R VOL	U CNC	Z VEL	RZ CAR	RS CEN	U CEN
070772	083019	*094953*	*103270*	*111661*	*122854*
683 13.0 Ht	712[12.4 Ma	647 11.4 Ht	658 13.0 Ht	688 9.5 Ht	669 10.6 Ht
V GEM	X UMA	652 11.5 Ht	678[12.7 En	X CEN	670 10.7 Bl
071713	083350	658 12.0 Ht	R UMA	*114441*	677 11.0 Ht
717 12.7 Pt	717 9.9 Pt	660 11.6 Bl	103769	647 12.9 Ht	678 10.9 En
S CMI	S HYA	670 12.0 Bl	683 11.5 Ah	652 12.8 Ht	680 11.6 Bl
072708	084803	V LEO	692 11.5 Ah	658 13.0 Ht	681 11.2 Ht
717 10.9 Pt	717 12.5 Pt	095421	692 11.5 Jo	660 13.0 Bl	688 12.0 Ht
718 12.0 Cm	T HYA	717 12.3 Pt	696 11.3 Ah	681[13.1 Ht	T UMA
T CMI	*085008*	RR CAR	700 11.8 Hf	AD CEN	123160
072811	717 9.3 Pt	*095458*	700 11.8 Wd	*114858*	682 7.7 Lu
717 11.2 Pt	T CNC	647 7.5 Ht	708 11.4 Wd	648 9.6 Ht	682 7.5 Fs
718 11.2 Ie	085120	652 7.4 Ht	709 10.8 Jo	652 9.5 Ht	683 7.2 Ah
S VOL	698 8.7 Lt	658 7.6 Ht	710 11.0 Ah	658 9.3 Ht	684 7.2 Ah
073173	717 8.3 Pt	RV CAR	712 11.3 Hf	669 9.6 Ht	685 7.5 Wg
647 11.2 Ht	718 8.5 Jo	*095563*	712 11.3 Cy	677 9.7 Ht	686 7.0 Mn
660 9.9 Bl	V UMA	652[13.1 Ht	712 10.6 Jo	681 9.6 Ht	689 7.3 Ah
670 9.2 Bl	090151	660[13.1 Bl	713 10.8 Hm	688 9.6 Ht	691 7.7 Ah
680 9.0 Bl	692 10.8 Jo	S CAR	715 11.0 Cm	697 9.4 Ht	692 7.7 Ah
683 9.1 Ht	712 10.4 Jo	*100661*	717 10.2 Pt	W CEN	692 7.5 Jo
U CMI	718 10.5 Jo	647 6.9 Ht	718 9.8 Jo	*115058*	693 7.9 Fs
073508	RW CAR	652 7.1 Ht	718 10.5 Wd	648 9.0 Ht	693 7.6 Ah
717 11.9 Pt	*091868*	658 7.7 Ht	718 10.5 Dl	652 8.8 Ht	694 7.9 Ah
725 12.1 Cy	648 12.7 Ht	658 7.2 Dk	718 9.8 Gy	658 8.5 Ht	695 7.9 Ah
S GEM	652 12.2 Ht	660 8.2 Bl	718 9.8 Cm	660 9.0 Bl	695 7.9 Rc
073723	658 11.7 Ht	666 8.1 Dk	719 10.6 Dl	669 8.8 Ht	696 7.8 Ah
717 12.0 Pt	Y VEL	669 8.6 Ht	719 10.6 Hm	670 9.0 Bl	697 8.0 So
718 11.9 Jo	*092551*	670 8.3 Bl	723 10.4 Dl	677 9.1 Ht	699 7.7 Lu
T GEM	647 12.0 Ht	673 8.4 Dk	724 9.2 Cy	678 9.2 En	699 8.0 Rc
074323	652 12.0 Ht	677 7.8 Ht	727 9.0 Gy	680 9.2 Bl	699 7.7 Hf
697 11.4 Hk	660 12.3 Bl	680 8.2 Bl	V HYA	681 9.4 Ht	700 8.0 Wd
717 9.8 Pt	R CAR	680 8.2 Dk	*104620*	686 9.5 En	705 8.0 Rc
718 9.8 Jo	*092962*	681 7.8 Ht	660 7.0 Bl	688 9.7 Ht	705 8.0 Md
718 10.2 Gy	647 9.5 Ht	686 8.2 Dk	RS HYA	697 9.7 Ht	706 8.2 Ah
727 10.1 Gy	652 9.6 Ht	688 7.5 Ht	*104628*	Z UMA	706 7.7 Jo
R CNC	658 9.6 Ht	694 7.0 Dk	660[12.5 Bl	115158	706 8.1 Lu
081112	658 9.2 Dk	704 6.5 Dk	RS CAR	682 8.1 Rb	706 8.1 Sz
696 9.9 Hk	660 9.4 Bl	U UMA	*110361*	685 8.3 Kp	707 8.1 Lu
717 9.7 Pt	666 9.3 Dk	100860	678[12.3 En	686 7.7 Rb	707 8.0 Kg
718 9.9 Jo	670 9.0 Bl	686 6.5 Mn	RY CAR	691 8.2 Rb	707 7.7 Hf
V CNC	673 9.3 Dk	692 6.4 Lt	*111561*	691 8.3 Kp	707 8.1 Cm
081617	680 9.2 Dk	709 6.5 Mn	652[13.1 Ht	701 8.6 Kp	707 8.3 Sx
727 8.2 Gy	680 8.7 Bl	710 6.5 Lt	660[13.1 Bl	706 8.6 Rb	708 8.0 Pt
RT HYA	686 8.9 Dk	Z CAR	678[13.1 En	707 8.8 Kp	709 8.5 Ah
082405	694 8.3 Dk	*101058a*	680[13.1 Bl	708 8.6 Rb	709 8.1 Hf
717 7.8 Pt	704 7.5 Dk	652[12.6 Ht	688[13.1 Ht	709 8.7 Rb	709 8.0 Sh
718 8.0 Jo	X HYA	660[12.6 Bl	RS CEN	RY UMA	709 8.0 Jo
R CHA	*093014*	W VEL	*111661*	121561	709 8.0 Mn
082476	727[11.8 Gy	*101153*	648 8.5 Ht	691 7.7 Lt	710 8.2 Ah
647 8.6 Ht	R LMI	647 8.9 Ht	652 8.2 Ht	709 7.8 Lt	710 8.1 Rc
652 8.8 Ht	093934	652 9.1 Ht	658 8.3 Ht	T CVN	711 8.2 Mc
658 8.8 Ht	717 10.5 Pt	658 8.7 Ht	660 8.3 Bl	122532	712 8.2 Rc
660 9.3 Bl	727 10.2 Gy	660 8.7 Bl	669 8.4 Ht	727 9.9 Gy	713 8.1 Jo
669 9.4 Ht	R LEO	670 8.5 Bl	670 8.2 Bl	U CEN	713 8.3 Mc
670 9.6 Bl	094211	680 9.1 Bl	677 8.5 Ht	*122854*	717 8.5 So
678 10.0 Ht	717 5.8 Pt	RZ CAR	678 8.6 En	647 9.4 Ht	717 8.4 Rc
680 10.2 Bl	718 6.4 Jo	*103270*	680 8.3 Bl	652 9.9 Ht	718 8.6 Cm
682 10.3 Ht		648 12.3 Ht	681 8.9 Ht	658 10.0 Ht	718 8.5 Gy
692 10.6 Ht		652 12.6 Ht	686 9.1 En	660 10.0 Bl	718 8.4 Hf

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
T UMA	S UMA	R HYA	T CEN	T APS	U UMI
123160	123961	*132422*	*133633*	*134677*	141567
718 8.6 Mc	713 7.8 Mc	692 7.4 Ht	688 6.2 Ht	688[13.2 Ht	706 10.3 Jo
718 8.3 Jo	713 7.9 Jo	695 6.8 Dk	692 6.4 Ht	RU HYA	706 10.3 Ah
720 8.6 Rc	717 8.0 Rc	697 7.6 Ht	697 6.6 Ht	*140528*	708 10.2 Pt
720 8.7 Mc	717 8.3 So	S VIR	RT CEN	647 10.9 Ht	708 10.3 Kn
721 8.8 Mc	717 8.0 Mc	*132706*	*134236*	652 11.2 Ht	709 10.0 Jo
722 8.8 Mc	718 8.4 Cm	647 9.4 Ht	647[11.7 Ht	658 11.4 Ht	710 10.3 Ah
724 8.7 Mc	718 8.5 Gy	652 8.9 Ht	652[11.7 Ht	660 11.4 Bl	714 10.0 Jo
727 8.9 Gy	718 8.3 Hf	658 8.3 Ht	658[11.4 Ht	669 12.1 Ht	715 10.1 Hf
RS UMA	718 7.8 Jo	669 7.4 Ht	660 13.1 Bl	670 12.0 Bl	718 10.5 Wa
123459	718 7.7 Mc	677 7.5 Ht	669 11.4 Ht	677 12.3 Ht	718 9.8 Jo
683 13.0 Ry	720 8.2 Rc	681 7.0 Ht	677 11.4 Ht	678 11.8 En	722 10.0 Hz
684 13.4 Bn	720 7.9 Mc	686 7.8 Hh	678 11.4 En	681 12.5 Ht	723 9.7 Cy
686 13.0 Ry	721 8.0 Mc	688 7.1 Ht	681 11.5 Ht	686 12.0 En	723 10.4 Ma
690 13.0 Ry	724 8.0 Mc	692 7.1 Ht	686 11.4 En	688 12.5 Ht	S BOO
693 13.2 Ry	727 8.6 Gy	697 7.3 Ht	688 11.3 Ht	692 12.4 Ht	141954
708[13.2 Pt	U OCT	RV CEN	692 11.2 Ht	R CEN	692 10.7 Jo
717[13.2 So	*131283*	*133155*	697 11.1 Ht	*140959*	694 11.0 Jo
723[13.6 Bn	648 8.5 Ht	647 7.4 Ht	R CVN	647 8.8 Ht	694 10.9 Ra
S UMA	658 8.6 Ht	652 7.3 Ht	134440	652 8.3 Ht	698 10.4 Cl
123961	658 8.0 Dk	658 7.3 Ht	683 9.4 Ah	658 8.8 Ht	700 11.5 Hf
672 8.6 Je	660 9.2 Bl	660 7.9 Bl	689 9.3 Ah	658 8.6 Dk	700 11.6 Wd
678 8.0 Je	665 8.8 Ht	669 7.6 Ht	691 9.3 Ah	660 8.3 Bl	708 11.8 Cl
682 8.2 Fs	666 9.0 Dk	670 7.5 Bl	692 9.1 Jo	666 8.9 Dk	708 11.7 Pt
682 8.3 Lu	669 9.6 Ht	677 8.0 Ht	693 9.2 Ah	669 9.1 Ht	709 12.2 Jo
683 7.7 Ah	670 9.6 Bl	680 7.7 Bl	694 9.0 Jo	670 8.0 Bl	709 11.9 Wd
684 7.7 Ah	673 9.6 Dk	681 8.4 Ht	695 9.3 Ah	673 8.1 Dk	712 12.0 Wd
685 7.4 Wg	678 9.5 Ht	686 8.2 En	696 9.1 Ah	677 9.3 Ht	712 12.0 Hf
686 7.9 Mn	680 9.8 Dk	688 8.1 Ht	705 8.5 So	680 8.7 Bl	718 12.2 Gy
689 7.5 Ah	680 10.0 Bl	697 8.4 Ht	706 8.8 Ah	680 9.3 Dk	RS VIR
691 7.5 Ah	682 10.0 Ht	T UMI	706 8.6 Jo	681 9.4 Ht	142205
692 7.6 Ah	686 10.0 Dk	133273	708 8.7 Hz	681 9.8 En	686 8.6 Ko
692 7.7 Jo	688 10.3 Ht	692 8.5 Jo	708 8.5 Pt	686 10.3 En	698 8.8 Ko
693 7.5 Fs	694 10.5 Dk	694 8.7 Jo	709 8.8 Ah	686 9.6 Dk	V BOO
693 7.6 Ah	697 10.3 Ht	705 9.1 Kn	709 8.5 Jo	686 9.7 Ht	142539a
694 7.7 Ah	699 10.6 Dk	706 8.7 Jo	710 8.7 Ah	692 9.7 Ht	683 9.6 Ah
695 7.6 Ah	705 10.8 Dk	707 9.2 Hf	713 8.6 Jo	692 9.9 En	684 9.5 Ah
696 7.7 Ah	V CVN	707 9.1 Wd	715 8.7 Jo	694 9.7 Dk	686 9.9 Mn
697 7.5 So	131546	709 8.8 Jo	RX CEN	695 9.9 En	687 9.6 Gw
699 8.0 Hf	690 8.1 Lt	709 8.9 Sh	*134536*	697 9.9 Ht	688 9.6 Wg
699 8.3 Lu	R HYA	712 9.0 Cy	647 9.5 Ht	699 9.6 Dk	689 9.5 Ah
699 7.6 Rc	*132422*	714 8.7 Jo	652 9.6 Ht	705 10.3 Dk	691 9.5 Ah
700 7.8 Wd	647 6.1 Ht	715 9.4 Hf	658 10.2 Ht	U UMI	692 9.2 Jo
706 7.7 Ah	652 6.1 Ht	718 9.0 Jo	660 9.8 Bl	141567	693 9.4 Ah
706 7.7 Jo	658 6.0 Ht	720 10.0 Gy	669 10.6 Ht	683 10.9 Ah	694 9.5 Sx
706 7.2 Sz	658 5.6 Dk	723 9.2 Cy	670 10.4 Bl	689 10.7 Ah	694 9.4 Ra
706 8.2 Lt	660 6.4 Bl	T CEN	677 11.0 Ht	691 10.7 Ah	696 9.2 Ah
707 8.1 Lu	666 5.8 Dk	*133633*	678 11.2 En	692 10.7 Ah	700 9.3 Wd
707 7.8 Kg	669 6.4 Ht	647 7.1 Ht	680 11.3 Bl	692 10.5 Jo	700 9.3 Hf
707 8.0 Sx	670 6.3 Bl	652 6.7 Ht	681 11.2 Ht	693 10.6 Ah	705 9.1 Cy
707 7.7 Cm	673 6.1 Dk	658 6.2 Ht	686 11.4 En	694 10.6 Ah	706 9.1 Ah
707 8.1 Hf	677 6.6 Ht	660 6.0 Bl	688 11.2 Ht	695 10.6 Ah	706 9.3 Gw
708 8.0 Pt	678 6.7 En	669 6.2 Ht	692 11.4 Ht	696 10.5 Ah	706 9.0 Jo
709 7.9 Jo	680 7.1 Bl	670 5.9 Bl	697 11.7 Ht	699 10.7 Wa	707 9.3 Sx
709 8.1 Mn	680 6.3 Dk	677 5.9 Ht	T APS	700 10.4 Hf	707 9.2 Hf
709 8.2 Sh	681 6.9 Ht	678 6.0 En	*134677*	700 10.3 Wd	708 9.3 Gw
709 7.8 Ah	682 6.8 En	680 6.2 Bl	648[13.2 Ht	705 10.3 Wa	708 8.8 Pt
710 7.8 Ah	686 6.5 Dk	681 6.2 Ht	660[13.2 Bl	705 10.8 Md	709 9.1 Ah
711 8.2 Mc	688 7.4 Ht	686 5.8 En	678[13.2 En	705 10.4 Fi	709 9.3 Wd

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V Boo	S Aps	S CrB	R Nor	R CrB	R CrB
142539a	*145971*	151731	*152849*	154428	154428
709 9.8 Mn	647 10.3 Ht	706 8.7 Pa	697 8.2 Ht	683 6.0 Be	691 6.2 Hk
710 9.1 Ah	658 10.5 Ht	706 9.0 Po	X Lib	683 6.2 Se	692 6.0 Lf
711 9.5 Mc	660 10.1 Bl	707 8.1 Be	*153020*	683 6.0 Rb	692 6.0 Dh
712 9.4 Mc	665 11.2 Ht	707 8.7 Kp	661 12.4 Bl	683 6.0 Ko	692 5.8 Jo
712 9.0 Sf	669 11.8 Ht	707 8.2 Wa	W Lib	684 6.0 Ah	692 6.1 Gl
713 8.7 Jo	670 11.4 Bl	707 8.2 Wp	*153215*	685 6.0 Kp	692 6.0 Ar
718 8.7 Jo	672 11.6 Bl	708 8.9 Fi	661[13.0 Bl	685 6.0 Fr	692 6.0 Tr
718 9.2 Mc	676 12.3 Bl	708 8.5 Wa	S UMi	685 6.0 Sc	692 6.1 Pb
718 9.0 Hf	677 12.1 Ht	708 8.6 Je	153378	685 6.0 Lf	693 6.0 Ah
719 9.1 Cy	680 12.3 Bl	708 8.1 Pt	692 12.1 Jo	685 6.0 Dh	693 6.0 Lf
720 9.2 Mc	681 12.8 En	709 8.6 Ah	708 11.9 Pt	685 6.0 Af	693 5.9 Dh
721 9.2 Mc	681 13.0 Ht	709 7.7 Jo	714 12.0 Jo	685 6.0 Rb	693 6.0 Rb
722 9.0 Sf	686 12.8 En	709 8.0 Mn	718 12.1 Jo	685 6.2 Si	693 6.1 Gl
723 9.1 Mc	688 12.9 Ht	710 8.5 Ah	U Lib	685 6.2 Se	693 5.9 Ar
724 9.0 Mc	692 12.5 En	711 8.3 Hv	*153620a*	685 6.0 Tr	693 5.9 Pb
R Cam	695 12.5 En	711 8.3 Bc	661[12.9 Bl	685 6.0 Ar	694 6.0 Sx
142584	697 12.4 Ht	712 8.0 Sf	T Nor	685 6.0 Pb	694 6.0 Jo
718 11.9 Gy	S Ser	712 8.6 Ba	*153654*	686 6.0 Cy	694 6.0 Ra
R Boo	151714	713 8.4 Ba	647 8.0 Ht	686 6.0 Rb	694 6.1 Gl
143227	692 10.1 Jo	713 7.8 Jo	652 8.5 Ht	686 5.9 Mn	695 6.0 Ah
692 11.8 Jo	700 9.6 Wp	715 8.2 Hf	665 9.5 Ht	686 5.9 Ko	695 6.0 Be
694 11.5 Ra	708 9.0 Pt	718 7.8 Jo	669 9.5 Ht	687 6.1 Gw	695 6.0 Rc
708 10.5 Pt	709 9.7 Jo	718 8.3 Ba	677 10.3 Ht	687 6.0 Ko	696 6.2 Ah
709 10.7 Jo	713 8.9 Jo	719 8.2 Wa	681 10.6 Ht	687 6.1 Pb	696 6.2 Kd
709 10.2 Wd	713 8.8 Kn	719 8.4 Hm	681 10.4 En	687 6.1 Bc	696 6.3 Cm
710 9.7 BH	713 8.6 Cy	719 8.4 Dl	686 10.8 En	687 5.9 Lf	696 6.1 Lf
713 10.5 Jo	715 9.0 BH	722 8.0 Sf	688 10.9 Ht	687 5.9 Dh	696 6.1 Dh
718 9.8 Jo	718 8.7 Jo	722 8.2 Wa	697 11.3 Ht	687 6.2 Si	696 6.1 Af
722 9.2 Hz	S CrB	722 8.2 Ba	RR CrB	687 6.3 Hr	696 6.2 Je
S Lup	151731	724 8.7 Mc	153738	687 6.1 Gl	696 6.1 Ar
144646a	683 10.1 Ah	RS Lib	696 8.1 Lt	687 5.9 Ar	696 6.1 Pb
648 12.1 Ht	684 10.0 Ah	*151822*	706 8.0 Lt	688 6.0 Ah	696 6.2 Kg
652 12.2 Ht	685 10.0 Kp	648 11.5 Ht	Z Lib	688 6.1 Bc	697 6.1 Ah
665 11.9 Ht	685 9.6 Se	652 12.0 Ht	*154020*	688 5.9 Lf	697 6.1 Lf
677 10.4 Ht	686 9.9 Mn	658 12.4 Ht	661 12.6 Bl	688 6.1 Pb	697 6.1 Dh
681 10.1 Ht	686 9.7 Ko	660 12.8 Bl	670 12.1 Bl	689 6.0 Ah	697 6.1 Ar
681 10.6 En	688 9.3 Bc	677 12.5 Ht	680 11.9 Bl	689 6.0 Be	697 6.1 Pb
686 10.4 En	689 9.1 Ah	681 11.7 En	R CrB	689 6.0 Cy	698 6.0 Pt
688 9.6 Ht	691 9.1 Ah	682 12.4 Ht	154428	689 5.9 Lf	698 5.9 Pb
697 9.4 Ht	691 9.3 Kp	686 11.7 En	651 6.1 Si	689 6.1 Si	698 6.2 Wp
X Lup	692 8.7 Jo	688 11.8 Ht	652 6.1 Kd	689 6.0 Gl	698 6.0 Ko
144646b	693 8.9 Ah	RU Lib	653 6.0 Si	689 5.9 Ko	698 6.1 Ah
652[12.1 Ht	694 8.8 Ra	*152714*	654 6.1 Si	690 5.9 Lf	698 6.2 Fi
677[12.1 Ht	695 9.0 Ah	708[13.1 Pt	655 6.4 Kd	690 6.1 Bc	698 6.0 Sc
681[12.1 En	696 9.0 Ah	R Nor	658 6.1 Si	690 5.9 Dh	698 5.9 Ar
688[12.1 Ht	699 8.9 Wa	*152849*	661 6.4 Kd	690 6.0 Pk	699 6.1 Ah
U Boo	700 8.7 Kp	647 10.9 Ht	663 6.1 Si	690 5.9 Ar	699 6.0 Wa
144918	701 8.5 B	652 10.8 Ht	667 6.1 Mw	690 5.9 Pb	699 6.1 Wd
698 10.1 Cl	701 8.6 Wp	661 9.9 Bl	671 6.3 Hr	691 6.0 Ah	699 6.1 Rc
705 10.3 Cl	703 8.7 Wa	665 10.1 Ht	676 6.3 Hr	691 6.0 Cy	699 6.0 Lu
720 9.9 Gy	703 8.7 Wp	669 9.7 Ht	677 6.4 Kd	691 5.8 Kp	699 6.1 Hf
Y Lup	704 8.7 Wa	670 9.5 Bl	678 6.2 Je	691 6.0 Lf	700 6.0 Kp
145254	705 8.5 Fi	677 9.1 Ht	679 6.4 Kd	691 6.3 Dh	700 6.0 Pb
652[12.8 Ht	705 8.5 Wa	680 8.5 Bl	679 6.4 Hr	691 6.0 Rb	700 6.1 Cy
660[13.7 Bl	706 8.6 Ah	681 8.8 En	679 6.1 Si	691 6.1 Tr	701 5.8 Pt
678[13.7 En	706 8.7 Ba	681 9.0 Ht	682 6.0 Rb	691 6.1 Ar	701 6.2 Wp
686[13.7 En	706 8.4 Jo	686 8.0 En	682 5.9 Ko	691 6.0 Pb	701 6.1 Sh
	706 8.3 Sz	688 8.9 Ht	683 6.0 Ah	691 5.9 Ko	701 6.0 Rb

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R CrB	R CrB	R CrB	V CrB	Z Sco	SX Her
154428	154428	154428	154639	*160021*	160325
701 6.1 Lu	708 5.9 Pt	718 6.0 Jo	706 7.2 Jo	652 9.5 Ht	717 8.3 Pt
701 6.2 Kd	708 6.0 Pb	718 6.0 Mc	707 7.6 Hf	658 9.4 Ht	718 8.6 Ba
703 6.0 Ah	709 6.1 Ah	718 6.5 Hm	708 7.0 Pt	661 9.0 Bl	718 7.8 Gy
703 6.2 Kd	709 6.0 Ba	719 6.0 Pt	709 7.5 Jo	669 9.3 Ht	718 8.9 Wd
703 6.1 Hu	709 6.1 Cy	719 6.1 Cy	711 7.6 Mc	670 9.4 Bl	718 8.6 Mc
703 6.2 Wa	709 6.4 Dl	719 6.0 Wa	713 7.6 Cy	677 9.6 Ht	719 8.4 Pt
703 6.1 Bc	709 6.2 Se	719 6.0 Ra	713 7 2 Jo	680 10.0 Bl	720 8.7 Mc
703 6.0 Ra	709 6.0 Rb	719 6.0 Kg	715 7.9 Cm	681 9.5 En	721 8.2 Pt
703 6.1 Pb	709 6.3 Rc	720 6.3 Cm	715 7.6 Hf	682 9.8 Ht	722 8.2 Ba
703 6.2 Wp	709 6.0 Jo	720 6.1 Cy	717 7.5 So	686 9.9 En	723 8.8 Mc
704 6.1 Ah	709 5.9 Mn	720 6.0 Gy	718 7.3 Mc	688 10.2 Ht	724 8.8 Mc
704 6.1 Cy	709 6.2 Kg	720 6.3 Kd	718 7.4 Jo	697 10.4 Ht	W Sco
704 6.2 Wa	709 6.4 Hm	720 6.5 Rc	720 7.4 Mc	705 9.8 Rc	*160519*
705 6.0 Ba	709 6.4 Sw	720 6.0 Mw	721 7.3 Mc	R Her	661 11.7 Bl
705 6.0 Be	710 6.1 Ah	720 6.0 Mc	724 7.5 Mc	160118	670 11.7 Bl
705 6.0 Cy	711 6.1 Hv	721 6.0 Pt	728 7.5 Md	677 10.6 Ko	680 12.2 Bl
705 6.0 Fi	711 6.0 Hu	721 6.2 Gy	R Lup	708 13.0 Pt	RU Her
705 6.0 Wa	711 6.1 Bc	721 6.0 Mw	*154736*	718 13.0 Gy	160625
705 6.1 Rc	711 6.1 Lf	722 6.2 Cm	681 11.5 En	724 13.2 Es	688[10.9 Bc
705 5.9 Pt	711 6.1 Gw	722 6.0 Ba	686 11.8 En	U Ser	708[12.9 Pt
705 6.1 Pb	711 6.0 Dh	722 6.0 Fi	RR Lib	160210	716[13.8 B
705 6.2 Wp	711 6.4 Rc	722 6.0 Wa	*155018*	708[12.3 Pt	R Sco
706 6.1 Ah	711 6.1 Pk	722 6.4 Rc	708 8.3 Pt	X Sco	*161122a*
706 6.0 Ba	711 6.2 Mc	722 6.0 Mc	Z CrB	*160221a*	652 11.3 Ht
706 6.0 Kp	711 6.1 Ar	723 6.1 Mc	155229	661 12.8 Bl	658 11.5 Ht
706 6.1 Bc	711 6.0 Pb	724 6.0 Kg	701 10.7 Wp	SX Her	661 11.3 Bl
706 6.1 Wd	712 6.0 Ba	725 6.0 Kg	707 10.6 Be	160325	670 11.2 Bl
706 6.0 Gw	712 6.1 Cy	X CrB	708 10.6 Wu	682 8.3 Ko	677 11.2 Ht
706 6.2 Se	712 6.1 Gy	154536	709 11.3 Jo	683 8.3 Ko	680 11.5 Bl
706 6.0 Rb	712 6.5 Rc	707 12.0 Be	712 10.2 B	686 8.4 Ko	681 11.8 En
706 6.0 Jo	712 6.0 Ra	718 11.3 Jo	713 10.8 Cy	688 8.5 Bc	682 11.2 Ht
706 6.1 Lu	712 5.8 Jo	R Ser	713 10.7 Jo	690 8.3 Sq	686 11.8 En
706 6.2 Gl	712 6.0 Mc	154615	718 10.7 Gy	692 8.5 Jo	688 11.5 Ht
706 6.1 Sz	712 6.3 Pt	692 11.1 Wu	T CrB	695 8.6 Sx	714 9.4 BH
706 6.7 Sw	713 6.2 Pt	692 10.4 Jo	155526	696 8.3 Lt	S Sco
706 5.9 Pt	713 6.0 Ba	701 10.4 Wp	698 9.8 Pt	698 8.3 Ko	*161122b*
706 6.2 Pb	713 6.1 Cy	705 10.2 Md	705 9.9 Pt	698 8.3 Pt	652[12.6 Ht
707 6.0 Ah	713 6.5 Rc	706 9.7 Jo	712 9.9 Pt	699 8.6 Hf	661[12.8 Bl
707 5.9 Kp	713 5.8 Jo	706 8.3 Es	RZ Sco	699 8.9 Wd	681[12.8 En
707 6.0 Wa	713 6.0 Mw	707 8.8 Hh	*155823*	701 8.3 Pt	688[12.6 Ht
707 6.1 Sx	713 6.5 Hm	707 10.2 Be	648 9.8 Ht	701 8.7 Sh	W CrB
707 6.2 Rc	714 6.3 Cm	708 9.8 Pt	652 9.5 Ht	705 8.4 Pt	161138
707 5.8 Jo	714 6.0 Wa	709 9.3 Jo	658 9.1 Ht	706 8.5 Pt	692 9.0 Jo
707 6.0 Lu	714 6.1 Mw	711 9.4 Hz	669 8.3 Ht	707 8.8 Hf	705 8.5 Md
707 6.2 Kg	715 6.4 Rc	713 8.8 Jo	677 8.2 Ht	708 8.2 Be	706 8.3 Jo
707 6.2 Gl	715 6.5 Kg	713 9.3 Cy	681 8.4 En	708 8.7 Sx	708 8.2 Be
707 6.3 Hr	715 6.1 Hf	715 9.1 BH	682 8.4 Ht	708 8.4 Pt	709 8.5 Cm
707 6.1 Hf	715 6.3 Pt	718 8.4 Jo	686 8.3 En	709 8.3 Lt	709 8.4 Jo
707 6.2 Wp	716 6.2 Pt	722 7.7 Hz	686 8.4 Dk	709 8.8 Wd	709 8.1 Lt
708 6.0 Fi	716 6.5 Rc	V CrB	688 8.5 Ht	709 8.4 Jo	712 8.2 B
708 6.0 Wa	717 6.1 Gy	154639	694 8.4 Dk	712 8.5 Pt	712 7.8 Pt
708 6.1 Fr	717 6.3 Pt	691 7.7 Pk	697 8.8 Ht	712 8.7 Mc	713 8.0 Jo
708 6.2 Lf	717 6.0 Mc	692 7.3 Jo	699 8.3 Dk	713 8.4 Jo	715 7.9 Jo
708 6.2 Gw	718 6.5 Cm	699 7.6 Hf	705 8.6 Dk	713 8.2 Ba	715 8.2 Hf
708 6.1 Af	718 6.0 Ba	700 7.8 Cm	715 9.3 BH	713 8.3 Pt	W Oph
708 6.1 Rb	718 6.0 Gy	701 7.4 B	Z Sco	715 8.3 Pt	*16·607*
708 6.5 Je	718 6.4 Rc	701 7.5 Sh	*160021*	715 8.6 Hf	712 12.6 Pt
708 6.1 Ar	718 6.2 Kg	705 7.6 Md	648 9.3 Ht	716 8.4 Pt	

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J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.
V OPH		W HER		W HER		S HER		RV HER		RU OPH	
162112		163137		163137		164715		165631		172809	
710	9.8 BH	690	8.6 Pb	723	9.7 Ma	707	9.6 Hf	712	11.0 Jo	701	9.3 Wa
712	9.0 Pt	692	8.5 Dh	724	9.9 Mo	709	9.1 Sh	712	11.3 Pt	702	9.4 B
U HER		692	8.6 Pb	R UMi		710	9.3 Be	717	11.8 So	705	8.8 Fi
162119		694	8.7 Sx	163172		710	9.6 Ah	RT SCO		705	9.0 Wa
686	11.4 Gw	695	8.6 Lt	694	10.3 Jo	711	9.5 My	*165636*		706	8.8 Es
694	11.5 Ra	696	8.4 Pb	699	10.4 Wd	712	9.5 Pt	661	11.0 Bl	708	9.3 Wp
698	11.4 Pb	697	8.5 Fr	707	10.4 Wd	713	9.0 Cy	670	11.8 Bl	710	9.8 BH
698	11.4 Gw	697	8.4 Sc	707	10.4 Jo	714	9.6 Jo	680	12.2 Bl	712	9.2 Pt
699	11.5 Wd	697	8.5 Lf	709	10.4 Wd	715	9.2 Hf	682	12.2 En	713	9.0 Jo
701	11.8 Wp	697	8.4 Dh	714	10.4 Jo	718	9.2 Jo	689	13.0 En	714	9.4 Jo
702	11.9 B	697	8.5 Af	715	10.3 Wd	718	8.8 Wd	R OPH		718	9.6 Gy
711	11.9 Hu	698	8.4 Fr	715	10.3 Hf	720	9.5 Dl	*170215*		719	9.6 Wa
711	11.8 Gw	698	8.4 Gw	718	10.0 Mc	723	9.1 Dl	687	9.3 Gw	720	9.9 BH
711	11.8 Ar	698	8.5 Af	718	10.3 Jo	RS SCO		692	10.0 Jo	721	9.6 Es
711	11.8 Pb	698	8.4 Pb	718	10.3 Wd	*164844*		710	11.0 BH	728	10.2 Es
712	12.4 Pt	698	8.6 Ko	R DRA		650	11.8 Ht	716	11.2 B	RT SER	
715	12.5 Jo	699	8.9 Wd	163266		652	11.6 Ht	RT HER		*173411*	
718	12.3 Gy	699	8.7 Hf	694	12.5 Jo	661	11.0 Bl	170627		717	11.3 Mc
718	12.2 Wd	700	8.7 Cm	699	12.1 Wd	670	10.3 Bl	685	15.1 Pf	723	11.1 Mc
g HER		700	8.6 Sc	707	11.9 Wd	677	10.3 Ht	712	12.5 Pt	RU SCO	
162542		700	8.6 Pb	707	12.3 Jo	680	9.7 Bl	RW SCO		*173543*	
695	5.3 Lt	701	8.8 B	709	11.8 Wd	681	10.5 En	*170833*		671	11.0 Bl
707	5.0 Lt	701	8.9 Sh	712	11.7 Pt	681	10.2 Ht	670	12.5 Bl	682	10.6 En
SS HER		701	8.9 Wp	714	12.0 Jo	685	10.0 Dk	689	12.5 En	689	10.8 En
162807		703	8.7 Pb	715	11.5 Wd	688	9.8 Ht	Z OPH		SV SCO	
692	10.2 Jo	706	8.7 Fr	718	11.4 Gy	689	10.1 En	171401		*174135*	
699	9.6 Wd	706	9.1 Gw	718	11.3 Wd	694	9.4 Dk	692	8.8 Jo	681	12.5 Bl
700	10.0 Wd	706	8.6 Af	718	11.5 Jo	697	9.8 Ht	700	9.3 Wd	682	12.2 En
700	10.1 Hf	706	8.8 Jo	723	11.1 Ma	699	9.2 Dk	700	9.4 Hf	689	12.2 En
701	10.2 B	706	9.1 Sz	RR OPH		705	9.0 Dk	701	9.0 B	W PAV	
707	10.5 Jo	706	8.6 Pb	*164319*		RR SCO		701	9.3 Sh	*174162*	
708	10.4 Be	707	9.1 Hf	682	9.0 En	*165030a*		706	9.2 Cm	648	9.8 Ht
712	11.1 Pt	707	8.9 Kn	686	9.1 En	650	9.5 Ht	707	9.2 Jo	652	10.0 Ht
713	11.0 Cy	708	9.1 Fr	692	9.0 Jo	652	9.5 Ht	707	9.2 Hf	658	9.8 Ht
713	11.0 Jo	708	9.2 Gw	702	9.4 B	661	10.2 Bl	708	9.5 Wp	669	10.0 Ht
718	11.8 Jo	708	9.1 Af	708	9.7 Kn	670	10.6 Bl	712	9.2 Pt	671	9.8 Bl
T OPH		708	9.1 Pb	712	9.4 Pt	677	11.6 Ht	714	9.5 Jo	677	10.1 Ht
162815		708	9.1 Hk	715	9.8 BH	680	11.2 Bl	715	9.6 Hf	681	10.2 Bl
661	12.8 Bl	709	9.3 Wd	722	10.0 Hz	681	11.5 Ht	RS HER		682	10.1 Ht
S OPH		709	9.1 Sx	S HER		682	11.1 En	171723		682	10.4 En
162816		709	9.0 Lt	164715		686	11.7 Dk	695	12.9 Es	688	10.3 Ht
661	12.6 Bl	710	9.2 Be	683	9.7 Ah	688	11.7 Ht	697	13.3 So	689	10.4 En
W HER		711	9.2 Hv	688	9.6 Bc	689	12.1 En	708	12.8 Es	697	10.7 Ht
163137		711	9.2 Hu	689	10.1 Ah	694	11.9 Dk	712	12.6 Pt	U ARA	
665	8.5 Lt	711	9.2 Gw	690	10.1 Sq	697	11.9 Ht	714	12.7 Jo	*174551*	
685	8.4 Fi	711	9.3 Dh	691	9.7 Ah	SS OPH		717	12.7 So	648	10.7 Ht
685	8.4 Lf	711	9.3 Ar	692	9.9 Jo	*165202*		717	12.5 B	652	10.2 Ht
685	8.4 Af	711	9.2 Pb	693	9.7 Ah	716	12.4 Es	723	12.5 Es	658	9.7 Ht
685	8.4 Ar	712	9.4 Jo	694	9.6 Jo	720	12.3 Gy	S OCT		669	8.9 Ht
685	8.4 Hk	712	9.3 Pt	695	9.9 Ah	723	12.1 Es	*172486*		677	8.7 Ht
686	8.2 Ko	712	9.4 Sf	696	9.7 Ah	RV HER		658	13.0 Ht	682	8.8 Ht
687	8.3 Lt	713	9.8 Cm	699	9.5 Wd	165631		670	13.0 Bl	682	8.6 En
687	8.4 Pb	715	9.6 Wd	701	9.9 Cm	692	10.1 Jo	689	12.8 En	688	8.8 Ht
687	8.3 Gw	715	9.5 Jo	701	9.4 B	697	10.4 Pf	RU OPH		689	9.3 En
688	8.5 Lf	715	9.6 Hf	701	9.4 Wp	697	10.5 So	172809		697	9.6 Ht
688	8.3 Pb	719	9.5 Cm	706	9.7 Jo	702	10.6 B	692	9.0 Jo	RT OPH	
690	8.6 Fr	719	9.6 Kg	707	10.0 Wp	705	10.5 Md	695	8.7 Es	175111	
690	8.6 Dh	722	10.0 Sf	707	9.9 Wa	707	10.5 So	699	9.2 Wa	708	10.6 Wp

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RT OPH	T HER	W DRA	W LYR	X OPH	R SCT
175111	180531	180565	181136	183308	*184205*
712 10.2 Pt	696 9.4 Je	724 10.9 Es	712 8.8 Jo	697 8.3 Ko	686 5.5 Se
713 10.2 Sf	698 9.6 Gw	X DRA	712 8.7 Hf	705 8.4 Rc	686 5.8 Rb
718 10.5 Jo	699 9.6 Wd	180666	712 9.0 Pt	706 8.6 Jo	686 5.8 Mn
718 10.3 Gy	699 9.6 Hf	697 11.2 Pf	713 8.9 Sf	706 8.3 Ko	686 5.5 Ko
722 10.2 Sf	699 9.5 Wa	713 11.3 Kn	714 9.0 So	707 8.5 Hf	687 5.4 Sc
T DRA	702 9.7 B	724 11.3 Es	715 8.6 Wd	707 8.8 Kp	687 5.4 Bc
175458a	706 10.8 Ba	NOV OPH	715 8.7 Jo	708 9.0 Kp	687 5.4 Lf
708 11.6 Wp	706 9.8 Gw	180911	716 8.6 Es	708 8.6 Sx	687 5.7 Gw
UY DRA	707 10.6 Hf	687 13.4 Ar	718 8.5 Kg	709 8.4 Sh	687 5.4 Dh
175458b	708 11.0 Bc	692 13.3 Ar	718 8.7 Wd	709 8.5 Mn	687 5.8 Gl
708 11.1 Wp	708 10.0 Gw	693 13.4 Ar	719 8.6 Md	710 8.3 BH	687 5.3 Tr
RY HER	708 10.5 Je	696 13.3 Ar	719 8.5 Kg	711 8.4 Hz	687 5.4 Ar
175519	709 10.3 Ah	697 13.4 Ar	722 8.5 Sf	711 8.3 Rc	687 5.4 Pb
692 9.3 Jo	709 9.9 Wh	711 13.4 Ar	RY SCT	712 8.5 Jo	687 5.4 Ko
702 9.1 B	709 11.1 Sh	RY OPH	*181912*	712 8.2 Pt	687 5.3 Hk
705 9.0 Kn	709 11.0 Fm	181103	712 9.4 Mc	715 8.3 Hf	688 5.4 Sc
705 8.7 Md	709 11.0 Sx	712 9.8 Pt	717 9.5 Mc	715 8.3 Jo	688 5.4 Bc
706 8.9 Jo	710 10.6 Ah	712 10.2 Kn	718 9.5 Mc	716 8.2 Rc	688 5.4 Lf
710 8.9 Md	710 10.9 Be	713 10.0 Md	720 9.6 Mc	718 8.2 Jo	688 5.5 Pb
712 8.8 Pt	711 10.6 Hu	714 10.1 Jo	721 9.5 Mc	720 8.0 BH	689 5.5 Lf
713 8.7 Jo	711 10.7 Gw	717 9.6 B	723 9.4 Mc	720 8.4 Cy	689 5.9 Gl
713 9.0 BH	711 10.8 Af	718 9.5 Jo	724 9.5 Mc	720 8.2 Hz	689 5.5 Pb
718 8.6 Jo	711 10.7 Ar	721 9.1 Es	RV SGR	722 8.1 Rc	689 5.3 Ko
723 9.4 Ma	711 10.7 Pb	W LYR	*182133*	RY LYR	690 5.0 Sq
V DRA	711 10.2 Ru	181136	672 10.2 Bl	184134	690 5.4 Fr
175654	712 11.2 Hf	683 9.9 Ah	681 10.3 Bl	685 13.1 Pf	690 5.6 Bc
691 11.4 Wu	712 11.2 Pt	685 10.4 Pk	682 11.0 En	697 12.3 So	690 5.6 Lf
707 10.4 Md	712 11.3 Wd	689 9.6 Ah	689 10.6 En	710 12.6 Be	690 5.4 Dh
712 10.2 Pt	712 11.0 Jo	692 9.6 Ah	SV HER	712 11.5 Pt	690 5.4 Af
713 10.2 Jo	713 11.3 Ba	693 9.6 Ah	182224	714 11.4 So	690 5.5 Ar
715 10.4 Jo	713 11.2 Cy	694 9.5 Ah	710 11.0 Be	720 10.9 Ie	691 5.6 Ar
718 9.9 Gy	713 10.5 Ru	694 9.7 Sx	712 11.2 Pt	723 13.9 Ma	691 5.5 Pb
724 9.7 Es	718 11.5 Gy	694 9.8 Ra	713 11.2 Jo	R SCT	691 5.5 Se
R PAV	718 12.0 Ba	695 9.5 Ah	717 10.8 B	*184205*	691 5.8 Rb
180363	718 12.0 Jo	696 9.4 Ah	718 10.5 Jo	652 5.3 Kd	691 5.2 Cy
648 12.5 Ht	720 12.4 Hz	697 9.9 So	T SER	655 5.4 Kd	691 5.4 Kd
652 12.6 Ht	724 12.4 Ba	699 9.3 Wd	182306	661 5.4 Kd	691 5.8 Kp
658 12.6 Ht	W DRA	699 9.5 Hf	713 13.8 Bs	676 5.3 Hr	691 5.5 Lf
677 12.1 Ht	180565	701 9.7 Cm	717 12.9 B	679 5.3 Hr	691 5.6 Dh
682 12.0 Ht	692 9.7 Jo	701 9.0 Sh	SV DRA	682 5.3 Ko	691 5.5 Ko
682 12.3 En	697 9.8 Pf	702 8.8 B	183149	682 5.1 Sq	691 5.5 Hk
688 12.0 Ht	699 9.9 Wa	706 9.1 Ah	719 13.6 Wp	682 5.9 Rb	692 5.4 Sc
689 11.4 En	701 9.9 Wa	706 9.0 Wd	RZ HER	683 5.5 Se	692 5.5 Lf
697 11.5 Ht	703 10.0 Wa	706 9.1 Md	183225	683 5.9 Rb	692 5.3 Dh
T HER	703 10.0 Wp	707 9.2 Kg	710 11.9 Be	683 5.4 Ko	692 5.5 Jo
180531	704 10.2 Wa	707 9.4 Cm	713 11.5 Jo	684 5.4 Be	692 5.4 Tr
683 8.8 Ah	705 10.0 Wa	707 9.1 Hf	718 11.2 Jo	685 5.6 Kp	692 5.8 Gl
687 8.8 Gw	707 10.0 Wa	708 8.9 Wd	718 10.8 Gy	685 5.4 Fr	692 5.4 Ar
689 8.9 Ah	711 10.7 Pf	709 8.9 Ah	721 10.9 Es	685 5.4 Sc	692 5.5 Pb
690 8.9 Sq	712 10.1 Jo	709 9.1 Sx	X OPH	685 5.6 Lf	693 5.5 Pb
692 9.2 Jo	712 10.9 Pt	709 9.0 Jo	183308	685 5.5 Dh	693 5.5 Ar
692 9.1 Ah	712 10.3 Kn	710 8.8 Ah	685 8.6 Si	685 5.5 Af	693 5.5 Dh
693 9.3 Ah	718 10.5 Jo	710 8.6 Be	686 8.4 Ko	685 5.5 Se	693 5.9 Rb
694 9.4 Ah	718 10.1 Wa	710 8.8 Wh	686 8.3 Mn	685 5.7 Rb	693 5.8 Gl
694 9.6 Sx	720 10.6 Wa	711 8.8 Pk	691 9.0 Kp	685 5.4 Tr	693 5.7 Fs
694 9.5 Ra	720 10.8 Fi	712 8.6 Cy	692 8.6 Jo	685 5.5 Ar	694 5.8 Sx
695 9.4 Ah	720 10.7 Wp	712 8.8 Sh	694 8.4 Sx	685 5.5 Pb	694 5.9 Ra
696 9.5 Ah	722 11.1 Wa	712 8.7 Wd	694 8.6 Ra	685 5.4 Hk	694 5.2 Jo

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R SCT	R SCT	R SCT	R SCT	NOV AQL	RX LYR
184205	*184205*	*184205*	*184205*	184300	185032
694 5.8 Gl	705 5.5 Af	711 5.6 Pb	722 6.0 Cy	703 10.8 Wp	708 11.7 Fr
695 5.9 Sx	705 5.5 Dh	711 5.5 Sq	722 5.5 Fi	705 10.8 Af	708 11.8 Gw
695 5.7 Rc	705 5.8 Rb	711 5.8 Hv	722 6.0 Mc	705 11.5 Pt	708 11.8 Pb
695 5.9 Gl	705 5.8 Rc	711 5.7 Hu	723 6.0 Mc	705 10.8 Pb	708 11.7 Hk
696 5.4 Cm	705 5.7 Kg	711 5.8 Bc	724 5.8 Ba	705 10.7 Hk	709 11.7 Wp
696 5.4 Kd	705 5.4 Pt	711 5.6 Lf	724 6.0 Mc	706 10.8 Pb	709 11.7 Fi
696 5.6 Kg	705 5.4 Pb	711 5.8 Gw	725 5.9 Kg	706 10.9 Fr	709 11.9 Wa
696 5.4 Fr	705 5.6 Hk	711 5.5 Dh	NOV AQL	706 10.8 Af	711 11.7 Hu
696 5.3 Af	706 5.5 Pb	711 5.9 Mc	184300	707 10.8 Gy	711 11.6 Gw
696 5.4 Dh	706 5.7 Ba	711 5.6 Ar	685 10.6 Fr	708 10.8 Fr	711 11.7 Dh
696 5.4 Ar	706 5.7 Kp	712 5.6 Ba	685 10.6 Af	708 10.7 Af	711 11.7 Ar
696 5.4 Hk	706 5.4 Fr	712 5.8 Cy	685 10.6 Tr	708 10.8 Pb	711 11.5 Pb
696 5.4 Pb	706 5.6 Bc	712 5.9 Gy	685 10.6 Ar	708 11.2 Hk	712 11.6 Pt
697 5.4 Pb	706 5.8 Wd	712 5.8 Wd	685 10.8 Hk	711 11.0 Bc	717 12.0 So
697 5.3 Ko	706 5.8 Gw	712 6.0 Ra	687 10.9 Sc	711 10.6 Gw	723 12.2 Wp
697 5.4 Bc	706 5.5 Dh	712 5.5 Jo	687 10.8 Tr	711 10.6 Ar	723 12.4 Wa
697 5.4 Sc	706 5.5 Af	712 5.8 Mc	687 10.8 Ar	711 10.6 Pb	S CRA
697 5.4 Fr	706 5.5 Se	712 5.6 Pt	687 10.8 Lf	712 10.4 Cy	*185437a*
697 5.4 Lf	706 5.9 Rb	713 5.6 Ba	687 11.3 Hu	712 10.7 Gy	648 11.8 Ht
697 5.4 Dh	706 5.4 Jo	713 6.0 Cy	688 10.6 Bc	712 10.3 Rc	652 11.7 Ht
697 5.5 Ar	706 5.8 Pa	713 5.6 Wa	690 11.0 Fr	712 11.3 Jo	665 11.8 Ht
698 5.7 Ah	706 5.3 Lu	713 5.7 Jo	690 11.0 Lf	712 11.6 Pt	672 12.0 Bl
698 5.4 Sc	706 5.9 Gl	713 5.8 Mc	690 11.0 Ar	717 10.8 Bs	678 11.7 Ht
698 5.4 Ar	706 5.4 Sw	713 5.4 Pt	690 10.9 Af	717 11.0 So	682 11.7 En
698 5.4 Pt	706 5.3 Pt	714 5.5 Pt	690 11.0 Pb	718 10.9 Gy	683 11.6 Ht
698 5.4 Pb	707 5.5 Ah	714 5.9 Rc	691 10.9 Sc	720 10.9 Cy	689 12.5 En
698 5.5 Ko	707 5.5 Be	714 5.6 Jo	691 10.9 Lf	721 10.6 Gy	692 12.1 Ht
699 5.7 Ah	707 5.8 Gy	714 5.7 Kg	691 10.9 Ar	S SCT	R CRA
699 5.4 Wa	707 5.9 Gl	715 5.5 Jo	691 11.0 Pb	*184408*	*185537a*
699 5.7 Wd	707 5.8 Kp	715 5.9 Hf	691 11.0 Hu	687 7.5 Lt	648 11.0 Ht
699 5.7 Rc	707 5.3 Wa	715 5.5 Pt	692 10.9 Ar	RX LYR	652 11.1 Ht
699 5.3 Lu	707 5.8 Rc	716 5.5 Pt	692 11.2 Jo	185032	665 11.4 Ht
699 5.7 Hf	707 5.6 Jo	717 5.9 Gy	693 10.8 Lf	685 14.3 Pf	672 12.5 Bl
700 5.2 Cy	707 5.2 Lu	717 5.9 Mc	693 10.8 Ar	687 14.0 Ar	678 11.5 Ht
700 5.8 Kp	707 5.6 Kg	717 5.5 Pt	693 10.8 Pb	687 14.0 Hk	682 11.7 En
700 5.5 Sc	707 5.4 Hr	718 5.6 Jo	694 11.4 Ra	687 14.0 Hu	683 10.7 Ht
700 5.7 Wd	707 5.9 Hf	718 5.9 Mc	696 10.5 Ar	690 14.0 Ar	689 11.1 En
700 5.4 Ar	708 5.4 Pb	718 5.7 Kg	696 10.6 Pb	690 13.9 Pb	692 10.3 Ht
700 5.5 Pb	708 5.4 Hk	718 5.9 Hf	697 11.0 Lf	690 13.9 Dh	T CRA
701 5.7 Kd	708 5.3 Wa	718 5.7 Ba	697 11.0 Ar	691 13.3 Ar	*185537b*
701 5.5 Wa	708 5.4 Fr	718 5.8 Cy	697 11.1 Pb	692 13.1 Ar	648 12.3 Ht
701 5.8 Rb	708 5.7 Bc	718 5.7 Gy	697 10.9 So	693 12.9 Ar	652 12.4 Ht
701 5.2 Lu	708 5.8 Wd	718 5.4 Wa	697 11.0 Hu	693 12.9 Pb	678 12.5 Ht
701 5.4 Pt	708 5.5 Af	719 6.0 Cy	698 10.8 Hu	696 13.0 Ar	682 13.0 En
703 5.5 Hu	708 5.7 Gw	719 5.6 Wa	698 10.9 Ar	697 12.8 Ar	683 12.5 Ht
703 5.2 Wa	708 5.9 Sx	719 6.0 Ra	698 11.6 Pt	697 12.9 Hu	692 12.5 Ht
703 5.4 Fr	708 5.9 Rb	719 5.6 Pt	698 10.9 Pb	697 12.5 So	Z LYR
703 5.7 Bc	708 5.5 Ar	720 6.0 Cy	698 11.0 Gw	698 12.7 Ar	185634
703 5.5 Af	708 5.4 Pt	720 6.0 Gy	698 10.9 Sc	698 12.7 Pb	697 10.4 So
703 5.9 Ra	709 5.7 Ah	720 5.7 Kd	700 10.7 Wa	698 12.7 Hu	705 10.6 Be
703 5.5 Ar	709 5.9 Cy	720 6.0 Hz	700 10.7 Sc	700 12.7 Wa	712 10.5 Jo
703 5.8 Kd	709 6.1 Fm	720 6.0 Mc	700 10.8 Ar	700 12.7 Ar	712 10.9 Pt
703 5.4 Pb	709 5.6 Se	721 5.8 Pt	700 10.8 Pb	700 12.7 Pb	715 10.8 Jo
704 5.2 Cy	709 5.9 Rb	721 5.9 Mc	700 10.9 Wp	700 12.6 Wp	717 11.4 So
704 5.1 Wa	709 5.9 Mn	721 5.9 Rc	703 10.8 Hu	703 12.1 Hu	717 11.4 B
705 5.7 Ba	709 5.2 Sw	721 6.0 Cy	703 10.8 Wa	703 12.2 Ar	718 11.4 Gy
705 4.9 Fi	710 5.9 Ah	721 5.8 Gy	703 10.9 Ar	703 12.2 Pb	
705 5.1 Wa	710 5.5 Be	722 5.5 Wa	703 10.9 Pb	705 11.9 Pb	

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J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
SU SGR			**RX SGR**			**TY AQL**			**T SGR**			**RY SGR**			**AF CYG**		
185722			*190818*			190907			*191017*			*191033*			192745		
648	8.3	Ht	720	10.9	Gy	719	10.5	Cy	690	11.6	Hu	715	7.4	Jo	656	7.0	Kd
652	8.4	Ht	**RW SGR**			724	10.6	Es	712	12.0	Pt	718	7.8	Wp	661	7.1	Kd
660	8.5	Ht	*190819a*			728	10.8	Es	**R SGR**			**TY SGR**			683	7.6	Ah
665	8.4	Ht	648	9.8	Ht	**S LYR**			*191019*			*191124*			689	7.6	Ah
678	8.4	Ht	652	9.9	Ht	190925			648	12.5	Ht	672	10.3	Bl	692	7.6	Ah
683	8.5	Ht	660	9.9	Ht	696	13.4	Wu	660	12.5	Ht	681	10.3	Bl	693	7.3	Ah
692	8.6	Ht	665	9.9	Ht	711	13.5	Wu	678	12.5	Ht	682	10.0	En	694	7.2	Ah
RT LYR			678	9.9	Ht	**X LYR**			682	12.0	En	692	10.2	En	696	7.1	Ah
185737			681	10.3	En	190926			687	11.9	Hu	713	10.5	Jo	697	7.1	Ah
685	13.6	Pf	683	10.5	Ht	712	9.0	Pt	690	11.8	Hu	715	10.5	BH	706	6.9	Ah
696	13.2	Wu	692	10.6	Ht	**RS LYR**			692	11.5	En	**S SGR**			710	6.9	Ah
697	13.5	So	709	11.3	Wa	190933a			692	11.9	Ht	*191319a*			**TY CYG**		
710	12.9	Wu	709	11.2	Wp	697	13.0	So	712	9.8	Pt	652	13.0	Ht	192928		
717	12.1	So	712	11.5	Pt	718	13.4	Gy	715	10.0	Jo	665	12.7	Ht	697	14.3	Pf
V AQL			720	11.4	Gy	**RU LYR**			715	10.1	BH	678	12.9	Ht	717	13.0	So
185905			**BH SGR**			190941			718	9.8	Wd	711	11.1	Bc	**RT AQL**		
686	7.8	Mn	*190819b*			685	14.6	Pf	719	9.8	Kn	718	12.2	Wd	193311		
709	7.8	Mn	709	13.4	Wp	710	12.9	Wu	**RY SGR**			**SW SGR**			712	13.4	Pt
R AQL			**TY AQL**			718	12.0	Gy	*191033*			*191331*			723	14.2	Ma
190108			190907			**U DRA**			648	8.3	Ht	672	11.3	Bl	**R CYG**		
686	11.0	Mn	685	10.6	Af	190967			652	8.5	Ht	682	12.1	En	193449		
689	11.1	Ah	685	10.7	Tr	691	13.7	Wu	658	7.9	Hk	689	12.1	En	687	12.4	Hk
692	11.3	Ah	685	10.6	Ar	697	13.7	Pf	661	7.8	Bl	**TZ CYG**			697	13.0	Hk
696	11.5	Ah	687	10.8	Sc	698	13.7	Ie	665	8.1	Ht	191350			697	13.0	Ar
697	11.4	Ko	687	10.8	Lf	718	13.8	Ie	666	7.7	Hk	685	11.2	Sc	699	13.1	Wd
697	11.5	So	687	10.8	Tr	**W AQL**			671	7.8	Bl	685	11.0	Tr	709	13.3	Es
702	11.2	B	687	10.8	Ar	*191007*			672	7.8	Bl	685	11.0	Ar	713	13.6	Bs
705	11.6	Wp	692	10.8	Tr	685	11.7	Af	673	7.6	Dk	685	11.1	Hk	720	13.8	Ie
706	11.3	Ko	692	10.7	Ar	685	11.7	Tr	678	8.0	Ht	687	11.1	Hk	723	13.4	Ma
709	11.8	Rb	693	10.8	Ar	685	11.7	Ar	679	8.9	Hr	687	11.1	Lf	**RV AQL**		
710	11.6	Ah	693	10.8	Pb	687	11.6	Ar	680	7.7	Dk	687	11.1	Tr	193509		
711	11.6	Hz	696	11.1	Ar	692	11.5	Ar	681	8.3	Bl	687	11.1	Ar	685	14.2	Ar
712	11.4	Cy	696	11.1	Pb	693	11.4	Ar	682	8.0	En	691	11.2	Pb	687	13.5	Ar
712	11.6	Pt	697	10.9	Fr	696	11.5	Ar	683	8.0	Ht	691	11.0	Hk	692	13.4	Ar
715	11.4	Jo	697	11.0	Lf	697	11.4	Ar	684	8.0	En	691	11.2	Ar	692	13.0	Wu
715	11.9	Wd	697	10.9	Ar	697	11.4	Pb	686	8.4	En	692	11.2	Ar	696	13.1	Ar
722	11.1	Fm	697	10.9	Pb	697	11.5	Hu	686	7.8	Dk	692	11.3	Dh	697	12.9	Ar
722	12.0	Hz	697	10.9	Hu	697	11.0	So	688	8.0	Ht	696	11.2	Ar	697	12.8	Pb
V LYR			697	11.0	So	698	11.4	Ar	688	8.5	Wg	697	11.0	Ar	697	13.0	Hu
190529a			697	11.1	Af	703	11.4	Ar	689	8.4	En	703	10.9	Ar	698	12.9	Pb
697	9.2	So	698	10.9	Ar	703	11.5	Hu	692	8.5	En	703	10.8	Pb	698	12.9	Ar
705	10.0	Md	698	10.9	Pb	703	11.4	Pb	692	8.2	Ht	703	10.7	Hk	703	13.0	Ar
705	9.6	Be	703	10.8	Hu	705	11.1	Wp	692	8.0	Jo	705	10.7	Hk	703	11.0	Hu
712	9.6	Pt	703	10.8	Ar	706	11.3	Pb	694	8.0	Jo	705	10.7	Wp	708	12.2	Wu
715	10.2	Jo	703	10.8	Pb	706	11.9	Fr	694	7.9	Dk	705	10.6	Pb	711	11.4	Ar
717	10.9	So	705	10.8	Wp	707	11.0	Md	695	8.5	En	711	10.6	Pb	711	11.4	Pb
718	10.3	Gy	706	10.5	Fr	708	11.1	Wp	697	8.5	Ht	711	10.7	Fr	713	11.9	Pt
RX SGR			706	10.5	Pb	711	11.0	Hu	699	7.8	Dk	711	10.6	Ar	717	10.5	So
190818			707	10.4	Md	711	10.9	Af	700	8.3	Wp	712	10.6	Pt	718	12.0	Gy
648	13.1	Ht	708	10.9	Wp	711	11.0	Ar	700	8.4	Wa	712	10.0	Jo	718	11.3	Jo
660	12.7	Ht	711	10.7	Hu	711	10.9	Pb	705	7.6	Dk	715	9.8	Jo	720	10.9	Ie
678	12.7	Ht	711	11.0	Af	712	10.4	Pt	705	7.8	Wp	718	9.9	Jo	**TT CYG**		
682	12.4	En	711	11.1	Ar	713	10.7	Md	706	8.0	Jo	718	10.5	Gy	193732		
692	12.0	Ht	711	11.0	Pb	714	10.8	BH	707	7.5	Jo	727	10.3	Gy	665	8.5	Lt
709	11.5	Wa	712	10.5	Pt	717	10.7	So	709	7.6	Jo	**U LYR**			687	8.0	Lt
709	11.3	Wp	713	10.4	Md	724	10.5	Es	712	7.7	Jo	191637			696	8.0	Lt
712	11.4	Pt	714	10.8	BH	728	10.3	Es	713	7.4	Jo	712	12.4	Jo	707	8.3	Lt
719	11.3	Cy	717	10.7	So				713	7.9	BH	712	12.0	Pt			

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
T PAV			**RT CYG**			**χ CYG**			**RR TEL**			**R CAP**			**RS CYG**		
193972			194048			194632			*195656*			*200514*			200938		
648	11.9	Ht	715	8.9	Wd	715	12.2	Wd	692[	12.6	En	713	11.8	Pt	686	7.3	Ko
652	11.4	Ht	715	8.7	Jo	715	12.3	Kg		**Z CYG**		716	12.1	B	687	7.2	Bc
665	9.5	Ht	718	9.0	Gy	717	11.6	B		195849			**S AQL**		687	7.7	Ar
669	8.6	Ht	718	9.3	Wd	718	11.7	Gy	687	8.9	Hk		200715a		687	7.6	Pb
672	8.7	Bl	720	9.1	Hz	718	11.7	Wa	692	8.3	Jo	690	10.9	Hu	687	7.7	Hk
678	8.4	Ht	720	9.8	Mc	718	11.9	Wd	693	8.8	Hf	691	10.5	Hu	688	7.7	Pb
682	8.1	Ht	722	9.1	Fi	718	11.8	Wp	699	8.8	Hf	691	10.7	Sc	689	7.7	Cy
683	8.0	Dk	722	9.1	Wa	719	12.2	Cy	705	9.2	Hk	691	10.4	Ar	689	7.7	Ar
686	7.7	Dk	722	9.9	Mc	720	11.9	Fi	705	9.3	Pb	692	10.7	Jo	689	7.7	Pb
688	7.9	Ht	723	9.2	Ma	720	11.9	Gy	709	8.8	Hf	696	10.6	Hu	691	7.7	Ar
694	7.6	Dk	724	9.9	Mc	720	11.8	Wa	709	9.3	Sx	697	10.4	Hu	691	7.7	Pb
695	7.4	En	727	9.6	Gy	720	12.0	Wp	709	8.7	Sh	705	10.4	Be	692	7.5	Pb
697	7.4	Ht	**TV CYG**			721	11.6	Gy	711	9.4	Hz	712	9.7	Jo	692	7.3	Jo
699	7.7	Dk	194348			723	11.2	Wa	712	8.7	Jo	713	9.7	Pt	692	7.7	Ar
705	7.6	Dk	682	11.3	Ry	723	11.1	Ma	713	8.7	Pt	718	9.4	Jo	693	8.1	Hf
RT CYG			686	11.4	Ry	723	11.3	Wp	715	8.9	Jo	719	9.3	Cy	693	7.5	Ar
194048			687	11.5	Hu	727	11.1	Gy	718	9.1	Jo	719	9.4	Wp	693	7.7	Pb
682	7.5	Fs	687	11.6	Hk	**S PAV**			722	9.6	Hz	720	9.4	Gy	694	8.0	Sx
682	7.3	Lu	687	11.5	Ar	*194659*			**S TEL**			**RW AQL**			696	7.7	Kg
683	7.2	Ah	690	11.7	Ry	684	7.5	En	*195855*			200715b			696	7.6	Ar
685	7.2	Se	694	12.0	Ry	695	7.5	En	648	12.8	Ht	687	9.1	Hu	696	7.6	Pb
686	6.8	Ko	696	12.1	Hk	**RR SGR**			652	12.9	Ht	692	9.3	Jo	697	7.6	Pb
687	7.4	Hk	699	12.0	Wd	*194929*			665	12.8	Ht	712	8.9	Jo	697	7.5	Hk
687	7.4	Hu	700	11.9	Ry	684	12.2	En	678	12.9	Ht	713	9.0	Pt	697	8.0	Hu
689	7.4	Ah	705	12.1	Wp	689	11.9	En	682	12.9	Ht	718	9.2	Jo	697	7.1	Ko
691	7.7	Pk	707	12.0	Wu	**RU SGR**			688	12.8	Ht	719	9.0	Wp	697	7.6	Ar
692	7.6	Ah	708	12.3	Ry	*195142*			**SY AQL**			719	9.2	Cy	698	7.5	Pb
693	7.6	Ah	708	12.1	Wd	648	11.6	Ht	200212			720	9.3	Gy	699	8.0	Wd
693	7.8	Hf	709	12.3	Md	652	11.7	Ht	692	9.3	Jo	**R TEL**			699	7.8	Cm
693	8.0	Fs	709	12.4	Es	672	9.5	Bl	699	9.6	Wa	*200747*			700	7.5	Pb
694	7.7	Ah	713	12.5	Pt	678	10.4	Ht	703	9.1	Wa	672[	12.4	Bl	701	8.0	Wd
696	7.8	Ah	715	12.4	Wd	682	9.5	Ht	705	9.1	Be	**RU AQL**			701	7.0	Lu
696	8.3	Hk	718	12.3	Wd	684	9.7	En	705	9.3	Wp	200812			702	7.6	So
697	7.9	Ah	718	12.7	Gy	688	8.9	Ht	707	9.4	Md	719	13.2	Wp	703	7.3	Ar
697	8.0	Ko	723	12.2	Ma	697	7.8	Ht	712	9.3	Jo	**W CAP**			703	7.3	Pb
699	8.1	Wd	**X AQL**			**RR AQL**			713	9.1	Pt	*200822*			703	7.4	Hk
699	8.0	Lu	194604			*195202*			713	9.3	Sf	672[	11.4	Bl	705	7.0	Be
699	7.9	Hf	694	11.7	Ra	708	13.4	Wp	713	8.7	Md	713[	12.5	Pt	705	7.7	Cy
701	8.1	Sh	700	11.6	Wd	**RS AQL**			716	9.0	Md	**Z AQL**			705	7.3	Pb
706	8.3	Ah	700	11.7	Hf	*195308*			716	9.1	Es	*200906*			706	7.4	Pb
706	8.2	Lu	702	11.6	B	714[	12.7	Jo	717	9.3	So	698	10.1	Cl	706	7.4	Fr
706	8.1	Ko	705	11.4	Be	720[	12.6	Gy	718	9.4	Gy	705	10.0	Be	706	7.4	Af
707	8.5	Wa	705	12.0	Wp	**NOV CYG**			718	9.4	Wa	710	10.4	BH	706	7.2	Lu
707	8.0	Jo	712	12.2	Hf	195553			719	9.4	Wp	713	11.0	Jo	708	7.9	Wd
707	8.2	Lu	712	12.3	Wd	685	13.8	Ar	722	9.3	Sf	713	11.0	Pt	708	7.5	Pb
707	8.5	Wp	713	12.2	Pt	687	13.5	Ar	727	8.8	Md	716	11.3	B	708	7.6	Hk
707	8.8	Hf	717	12.6	Bs	687	13.4	Hu	**S CYG**			718	11.3	Wa	709	8.4	Sx
708	8.5	Wd	717	12.9	So	692	13.5	Ar	200357			**R SGE**			709	7.3	Lu
709	8.3	Es	**χ CYG**			696	14.1	Ar	694	11.6	Ra	200916			709	8.1	Hf
709	8.5	Hz	194632			697	14.1	Ar	696	12.0	Hk	692	9.2	Jo	709	7.8	Sh
709	8.7	Sx	687	13.3	Tr	711	13.8	Ar	699	12.0	Wd	712	9.1	Jo	711	7.2	Je
709	8.7	Lu	687	13.3	Ar	**RR TEL**			705	12.0	Wp	718	9.4	Jo	711	7.7	Ar
710	8.6	Ah	699	13.0	Wd	*195656*			713	12.3	Pt	**RS CYG**			711	7.4	Pb
711	8.4	Pk	707	12.7	Wd	648[	12.8	Ht	718	11.9	Gy	200938			712	7.7	Cy
712	8.3	Jo	710	12.3	Es	665[	12.8	Ht	718	12.7	Wd	680	8.3	Cy	712	7.2	Jo
712	9.3	Mc	712	12.4	Hf	684[	12.6	En	719	12.5	Wp	685	7.7	Ar	713	7.0	Wh
713	8.6	Pt	712	12.4	Wd				727[	12.3	Gy	685	7.5	Pb	713	7.2	Hz
715	9.0	Hf	715	12.6	Cm							685	7.3	Si	713	7.9	Kg

Variable Star Observations Received During October, 1934.

J.D.	Est.	Obs.
RS Cyg		
200938		
713	7.0	Pt
713	7.8	So
714	7.3	BH
715	7.4	Jo
718	8.1	Wd
718	7.6	Kg
718	8.2	Hf
R Del		
201008		
711	11.7	My
712	11.7	Bs
712	12.0	Jo
713	11.6	Pt
715	11.8	Jo
715	11.3	BH
717	11.7	My
717	11.7	So
718	11.2	Jo
718	11.3	Kn
719	11.4	Wp
722	11.3	My
723	11.2	Mc
SX Cyg		
201130		
687	11.5	Fr
698	12.1	Fi
698	12.0	Wp
699	12.3	Wp
699	12.5	Wa
713	12.4	Pt
718	12.6	Gy
RT Sgr		
201139		
672	10.0	Bl
WX Cyg		
201437b		
685	10.5	Ar
685	10.5	Hk
687	11.0	Ar
687	10.8	Hk
689	10.7	Ar
689	10.7	Pb
691	10.8	Ar
691	10.8	Pb
692	10.7	Ar
692	9.3	Jo
693	10.0	Hf
693	10.6	Ar
693	10.6	Pb
695	10.4	Es
695	10.8	Sx
696	10.4	Es
696	9.5	Cm
696	10.6	Ar
696	10.6	Pb
696	10.6	Hk
696	9.4	Kg
696	10.5	Md
697	10.8	Hk
697	10.5	Pb
697	10.7	Sc
697	10.8	Ar
698	10.4	Pb
699	9.7	Wd
699	10.1	Hf
700	10.3	Pb
701	9.8	Wd
702	10.6	So
703	10.3	Ar
703	10.3	Pb
703	10.3	Hk
705	10.4	Cy
705	10.5	Pb
705	10.7	Md
705	10.3	Es
706	10.4	Fr
706	9.9	Wd
706	10.4	Af
706	10.4	Pb
708	9.9	Fr
708	10.0	Wd
708	9.8	Af
708	9.9	Pb
708	9.8	Hk
709	11.0	Bs
709	11.0	Sx
709	10.0	Hf
711	10.6	Ar
711	10.4	Pb
712	9.1	Jo
713	9.5	Cy
713	10.7	Md
713	10.6	So
714	9.7	BH
715	9.3	Jo
715	9.8	Wd
718	9.9	Wd
718	10.0	Hf
728	10.0	Es
V Sge		
201520		
685	12.0	Rb
703	11.9	Wa
703	11.8	Wp
709	12.1	Rb
711	11.7	Ar
711	11.6	Pb
718	11.9	Gy
719	12.5	Wp
720	12.8	Gy
721	12.5	Gy
722	12.6	Wp
U Cyg		
201647		
683	7.4	Ah
685	7.5	Kp
685	6.7	Se
687	7.5	Hk
689	7.5	Ah
691	7.5	Cz
691	7.7	Kp
691	6.9	Se
692	7.4	Ah
693	7.4	Ah
693	7.5	Fs
693	7.8	Hf
694	7.3	Ah
695	8.0	Sx
696	7.4	Ah
697	7.3	Ah
697	7.0	Ko
698	7.8	Wp
698	7.8	Fi
699	7.7	Wd
699	7.5	Lu
699	7.9	Hf
700	7.5	Kp
701	7.7	Sh
701	7.5	Lu
702	7.8	So
705	7.5	Md
706	7.3	Ah
706	7.6	Kp
706	7.4	Lu
707	7.6	Kp
707	7.7	Wa
707	7.4	Lu
707	7.8	Wp
708	7.6	Kp
708	7.1	Fm
708	7.7	Af
708	7.6	Pb
708	7.7	Hk
709	7.3	BH
709	8.0	Sx
709	7.0	Lu
709	7.6	Hf
710	7.4	Ah
710	7.1	Wh
711	7.5	Je
712	7.4	Jo
712	7.8	Mc
712	7.4	Cz
713	7.0	Pt
713	7.5	Kn
713	7.4	Hz
713	7.8	So
714	7.8	So
715	7.3	So
718	7.7	Kg
718	7.6	Sf
718	7.4	Jo
718	7.6	Wd
719	8.0	Cy
U Cyg		
201647		
720	7.8	Cm
720	7.5	Hz
720	7.9	Mc
722	7.9	Mc
724	7.7	Mc
U Mic		
202240		
672	[12.1	Bl
Z Del		
202817		
685	9.1	Af
685	9.1	Tr
685	9.1	Ar
687	9.0	Ar
687	9.0	Tr
687	9.0	Lf
687	9.0	Sc
692	8.9	Lf
692	9.0	Dh
692	8.9	Ar
695	8.7	Es
696	8.8	Ar
696	8.8	Pb
697	9.0	Ar
703	9.0	Ar
703	9.0	Pb
703	9.0	Hu
703	9.0	Hk
203905		
705	8.8	Hk
705	8.9	Pb
705	8.7	Be
706	9.2	Fr
706	9.1	Pb
708	9.2	Pb
708	9.0	Hk
708	9.3	Fr
711	9.2	Fr
711	9.1	Ar
711	9.1	Pb
712	8.8	Jo
713	8.6	Pt
713	9.4	So
717	9.4	Bs
718	8.9	Wa
720	9.2	Gy
723	9.1	Ma
728	9.1	Es
ST Cyg		
202954		
687	13.5	Ar
687	13.5	Hk
696	13.4	Hk
698	13.5	Ie
713	12.3	Pt
718	12.2	Gy
718	12.5	Ie
726	11.8	Gy
V Vul		
203226		
713	9.1	Pt
R Mic		
203429		
672	10.7	Bl
Y Del		
203611		
713	10.4	Mw
713	10.0	So
720	11.2	Gy
720	11.1	Mw
721	11.4	Mw
S Del		
203816		
705	11.0	Cy
705	11.1	Wp
707	11.4	Md
712	12.4	Jo
713	11.7	Pt
719	12.1	Cy
V Cyg		
203847		
687	12.4	Hk
699	13.0	Wd
713	13.2	Pt
718	12.8	Wd
723	13.2	Ma
Y Aqr		
203905		
709	[12.0	Wd
718	[13.3	Ie
T Del		
204016		
685	9.6	Af
685	9.5	Ar
685	9.5	Fr
685	9.6	Hk
687	9.6	Lf
687	9.6	Tr
687	9.6	Ar
687	9.6	Hu
690	9.3	Hu
691	9.4	Hu
691	9.3	Sc
691	9.4	Pb
696	9.5	Ar
696	9.5	Hu
698	9.5	Hu
699	8.9	Wa
703	9.2	Hu
703	9.1	Ar
703	9.2	Pb
704	9.3	Wa
705	8.9	Be
705	9.2	Cy
706	9.5	Fr
706	9.3	Wd
706	9.6	Af
706	9.5	Pb
T Del		
204016		
708	9.7	Fr
708	9.7	Af
708	9.6	Pb
708	9.3	Hk
711	9.3	Ar
711	9.3	Pb
711	9.3	Fr
712	9.0	Jo
712	9.5	Bs
713	9.3	So
713	8.8	Pt
718	9.4	Wa
719	9.6	Wp
719	9.3	Cy
U Del		
204017		
673	7.0	Lt
687	6.7	Lt
695	7.0	Lt
710	6.9	Lt
V Aqr		
204102		
666	8.6	Lt
687	8.6	Lt
694	8.9	Jo
706	9.2	Md
709	9.0	Lt
710	9.2	Es
712	9.0	Kn
713	8.9	Pt
713	8.9	Jo
727	9.0	Md
728	8.7	Es
W Aqr		
204104		
694	10.2	Jo
708	11.3	Kn
713	10.6	Jo
719	11.9	Cy
U Cap		
204215		
672	[11.5	Bl
716	[13.8	B
V Del		
204318		
687	14.8	Hu
687	14.7	Ar
713	[13.1	So
721	[13.1	Gy
T Aqr		
204405		
683	11.0	Sq
686	10.3	Mn
687	10.9	Bc
694	11.9	Jo
696	11.3	Kg
707	11.7	Wd
709	12.2	Wd

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
T AQR			R VUL			T CEP			X PEG			S CEP			U AQR		
204405			205923a			210868			211614			213678			*215717*		
711	12.5	Bs	695	7.6	Ah	686	10.3	Mn	713	11.3	Pt	717	9.6	Mc	713	13.5	Pt
713	12.7	Pt	696	7.8	Ah	687	9.8	Gw	718	11.1	Gy	718	8.5	Jo	S PSA		
713	12.5	Jo	697	8.0	Md	689	10.2	Ah	718	11.1	Kn	718	9.5	Rc	*215828*		
719	12.5	Cy	699	8.2	Hf	690	9.8	Sq	723	10.9	Ma	719	9.4	Cy	684	9.1	En
RZ CYG			705	8.4	Md	691	10.2	Ah	T CAP			721	9.6	So	691	9.0	En
204846			706	8.2	Ah	691	10.5	Pk	*211615*			722	9.3	Sf	TW PEG		
696	12.1	Hk	707	8.3	Ah	691	10.1	Kp	672	10.5	Bl	722	9.6	Mc	215927		
700	12.2	Wp	709	8.2	Sh	692	10.3	Ah	713	9.6	Jo	724	9.3	Ba	665	7.8	Lt
700	12.2	Wa	709	8.2	Hf	693	10.3	Hf	S MIC			RU CYG			687	7.4	Lt
708	12.3	Pb	710	8.2	Ah	693	10.4	Ah	*212030*			213753			695	7.7	Lt
708	12.3	Hk	712	8.6	Jo	694	10.2	Ra	672[	11.9	Bl	682	8.0	Ry	707	7.6	Lt
713	12.4	Mw	713	8.6	Hz	694	10.6	Ah	684	11.8	En	686	8.1	Ry	RT PEG		
713	12.8	Pt	713	8.2	Pt	695	10.3	Ah	691	10.5	En	690	8.2	Ry	215934		
718	12.5	Wp	714	8.7	BH	695	10.4	Sx	695	10.2	Dk	694	8.2	Jo	712	10.9	Ma
S IND			715	8.4	Jo	696	10.3	Ah	705	9.7	Dk	696	8.4	Cl	723	11.0	Ma
204954			717	9.0	Bs	700	9.8	Kp	Y CAP			698	8.3	Ry	724	10.6	Es
648[	13.5	Ht	718	9.0	Hf	701	10.3	Wd	*212814*			708	8.2	Ry	727	10.4	Md
665[	13.5	Ht	722	9.0	Hz	701	9.9	Lu	672[	12.5	Bl	711	8.1	Cl	RY PEG		
672[	13.1	Bl	724	9.4	Fi	705	10.3	Pb	W CYG			711	8.2	Je	220133a		
682[	13.5	Ht	724	9.4	Wp	705	10.3	Hk	213244			712	8.6	Jo	706	10.5	Pb
X DEL			727	9.6	Md	706	9.8	Lu	652	6.0	Kd	713	9.1	Mc	RZ PEG		
205017			728	9.6	Es	706	10.4	Pb	661	6.0	Kd	713	8.4	Pt	220133b		
687	13.0	Hr	V CAP			707	10.4	Hf	679	6.2	Kd	715	8.5	Jo	706	11.8	Pb
687	12.6	Sc	*210124*			708	10.1	Kp	711	6.4	Mc	717	8.9	Mc	708	9.5	Hk
691	12.2	Sc	672	9.0	Bl	708	9.8	Gw	712	6.4	Mc	718	8.5	Wp	713	8.7	Pt
691	12.5	Hu	691	9.2	Kn	708	10.4	Pb	713	6.4	Mc	719	8.7	Cy	727	9.1	Gy
697	12.2	Hu	718	10.3	Kn	708	10.3	Hk	717	6.4	Mc	722	8.6	Wp	Y PEG		
697	12.2	Tr	TW CYG			709	10.4	Sx	718	6.4	Mc	724	8.9	Mc	220613		
697	12.3	Ar	210129			709	10.4	Mn	719	6.5	Kd	RV CYG			710	10.0	Md
700	11.9	Wp	718	14.0	Ie	709	10.2	Kg	720	7.4	Mc	213937			718	11.0	Kn
700	12.0	Wa	X CAP			710	10.6	Ah	721	6.4	Mc	713	6.4	Pt	718	10.6	Gy
707	10.9	Md	*210221*			711	10.3	Pk	722	6.4	Mc	RR PEG			727	10.9	Gy
712	10.2	Bs	672[	12.1	Bl	711	10.5	Pb	723	6.4	Mc	214024			727	10.7	Md
713	9.8	Pt	713[	13.0	Pt	712	10.4	Bs	724	6.4	Mc	712	13.8	Ma	RS PEG		
714	10.2	So	X CEP			713	10.3	Kn	S CEP			723	13.9	Ma	220714		
UX CYG			210382			713	9.5	Pt	213678			724	14.0	Es	718[	13.1	Gy
205030a			718	11.9	Gy	713	10.3	Hz	690	8.7	Sq	R GRU			727[	12.5	Gy
687[	13.0	Hk	718	12.0	Wp	713	10.2	Rc	693	9.2	Hf	*214247*			R PSA		
700[	13.0	Wa	720	11.9	Gy	713	10.0	Jo	694	8.0	Ra	648	11.2	Ht	*221230*		
718[	12.4	Gy	727	11.7	Gy	715	10.5	Hf	694	8.1	Jo	652	10.3	Ht	684	10.2	En
727[	11.5	Gy	RS AQR			717	10.2	Mc	695	9.4	Sx	665	9.2	Ht	691	10.2	En
UY CYG			*210504*			718	10.0	Wd	696	9.3	Je	669	8.8	Ht	X AQR		
205230			713[	12.9	Pt	722	10.2	Mc	696	9.3	Md	672	8.9	Bl	*221321*		
700	11.3	Wa	Z CAP			RR AQR			701	8.8	Wp	678	8.5	Ht	691	8.9	Kn
700	11.4	Wp	*210516*			*210903*			706	8.3	Jo	682	8.3	Ht	705	9.2	Wp
718	11.3	Gy	707	9.8	Jo	694	9.5	Jo	706	8.8	Ba	684	8.6	En	707	9.0	Wp
723	10.9	Wa	713	10.8	Pt	713	10.5	Pt	707	9.3	Hf	688	8.3	Ht	707	9.1	Wa
723	11.0	Wp	716	10.7	B	Y PAV			708	9.0	Je	691	8.2	En	707	8.7	Jo
R VUL			R EQU			*211570*			709	9.2	Sx	697	8.3	Ht	709	9.2	Fi
205923a			210812			648	6.0	Ht	712	9.2	Wp	VV CEP			709	9.0	Wa
683	7.9	Ah	713[	12.9	Pt	652	6.2	Ht	713	9.4	Md	215363			709	8.9	Wp
686	7.9	Md	723[	12.9	Ma	665	6.2	Ht	713	9.0	Sf	673	5.5	Lt	713	8.7	Mw
688	7.8	Ah	T CEP			678	5.8	Ht	713	9.0	Kn	687	5.4	Lt	713	8.9	Jo
689	7.8	Ah	210868			682	5.8	Ht	713	8.0	Pt	V PEG			714	9.0	Wa
692	7.7	Ah	682	10.3	Lu	688	5.8	Ht	713	9.5	Ba	215605			714	8.5	BH
693	7.6	Ah	682	10.2	Fs	697	5.8	Ht	714	8.6	Jo	713	13.5	Pt	714	9.0	Wp
693	8.0	Hf	683	10.4	Ah				715	9.2	Hf	U PSA			715	9.0	Jo
694	7.4	Ah	685	9.9	Kp				717	9.2	Ba	*215628*			718	9.4	Kn
												691[	13.0	En			

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
X AQR	R LAC	R PEG	V PHE	Z AND	R AQR
221321	223841	230110	*232746*	232848	*233815*
719 9.3 Wp	715 9.2 Hf	711 8.0 My	665 11.6 Ht	719 10.7 Cy	694 9.8 Jo
720 8.9 Wp	718 9.5 Jo	712 8.0 Jo	669 11.5 Ht	720 10.6 Kn	695 9.1 Sx
720 9.4 Mw	720 9.9 Mc	712 8.3 Sf	678 10.5 Ht	723 10.3 Ma	697 9.1 Ht
720 9.0 Wa	RW PEG	713 8.5 Ru	682 10.4 Ht	727 10.7 Gy	699 9.2 Hf
721 9.5 Mw	225914	713 8.0 Pt	688 10.3 Ht	ST AND	699 9.1 Wa
724 9.2 Wp	690 13.2 Pb	714 8.5 So	691 10.0 En	233335	699 9.1 Ko
T GRU	693 13.2 Pb	715 7.9 Jo	697 10.1 Ht	682 10.5 Sq	700 9.2 Wa
221938	693 13.3 Ar	715 8.2 Hf	Z AND	692 10.5 Jo	700 9.3 Wd
684 11.3 En	697 13.3 Hu	717 8.4 My	232848	697 10.2 Sc	700 9.2 Hf
691 10.7 En	697 13.3 Hk	718 8.8 Wa	680 10.7 Cy	697 10.3 Pb	700 9.1 Wp
S GRU	698 13.3 Ar	718 8.4 Kn	683 10.7 Cy	697 10.4 Hk	704 9.1 Wa
221948	698 13.1 Fr	720 8.6 Wa	685 10.7 Lf	703 10.3 Pb	706 9.6 Ko
652[12.8 Ht	698 13.3 Pb	720 8.5 Wp	685 10.7 Ar	703 10.4 Hk	706 9.2 Rb
682 13.0 Ht	708 13.2 Fr	720 8.2 Cm	685 10.7 Pb	705 9.9 Pb	706 9.7 Jo
684 13.4 En	708 13.0 Hk	720 8.5 Fi	686 10.7 Cy	705 9.9 Hk	707 9.7 Jo
688 12.9 Ht	708 13.2 Pb	722 8.5 Sf	687 10.7 Hu	706 10.4 Pb	707 9.2 Hf
691 12.8 En	711 12.4 Pb	722 8.4 My	687 10.7 Lf	706 10.5 Fr	708 9.2 Bc
RV PEG	711 12.9 Bs	V CAS	687 10.6 Ar	706 10.6 Af	708 9.2 Rb
222129	711 12.4 Ar	230759	687 10.7 Pb	707 10.1 Jo	708 9.4 Kn
727[13.1 Gy	712 12.2 Ma	683 10.3 Ah	688 10.7 Pb	708 10.3 Cy	709 9.4 Sx
S LAC	713 11.8 Pt	683 10.4 Wg	689 10.9 Pb	708 10.6 Af	709 9.4 Rb
222439	714 12.7 Wp	689 10.3 Ah	689 10.9 Ar	708 10.6 Pb	709 9.4 Hf
710 11.4 Es	714 12.3 So	690 10.2 Sq	690 10.8 Pb	708 10.7 Hk	710 9.5 BH
712 11.5 BL	714 12.6 Wa	694 10.4 Ah	691 10.8 Cy	711 10.3 Af	711 9.1 Hv
713 11.6 BL	718 12.0 Wa	696 10.6 Ah	691 10.8 Lf	711 10.2 Tr	711 9.1 Bc
713 11.1 Pt	721 11.6 Kn	701 11.1 Po	691 11.0 Pk	711 10.1 Ar	711 9.7 Bs
718 11.7 BL	723 11.9 Ma	713 11.1 Pt	691 10.7 Ar	711 10.2 Pb	712 9.5 Cy
724 10.3 BL	R PEG	719 11.5 Kn	691 10.7 Pb	711 10.8 Bs	712 9.8 Jo
R IND	230110	719 11.0 Cy	692 10.8 Lf	712 10.3 BL	712 9.7 Ma
222867	683 8.1 Ah	719 11.1 B	692 10.6 Jo	712 9.6 Jo	713 9.7 Jo
678 13.4 Ht	685 7.8 Fr	W PEG	692 10.8 Ar	713 10.2 BL	713 9.2 Pt
682 13.4 Ht	685 7.9 Af	231425	692 10.7 Pb	713 9.8 Pt	714 9.6 Jo
684 13.0 En	685 8.0 Tr	685 11.8 Ar	693 10.8 Lf	715 9.5 Jo	715 9.6 Jo
688 12.9 Ht	685 7.9 Ar	685 11.9 Hk	696 10.7 Ar	717 10.0 My	715 9.3 Hf
697 12.3 Ht	685 8.1 Hk	719 12.0 Cy	696 10.7 Pb	718 10.1 BL	718 9.4 Gy
W CEP	688 7.9 Ah	S PEG	697 10.7 Pb	719 10.3 Cy	718 9.7 Jo
223257	689 8.0 Ah	231508	697 10.7 Ar	722 9.9 My	718 9.3 Wa
687 7.8 Lt	692 8.0 Ah	692 8.0 Jo	698 10.8 Pb	724 10.4 BL	718 9.3 Hf
696 7.8 Lt	692 7.6 Sc	697 8.1 Ah	700 10.7 Pb	R AQR	719 9.6 Wp
707 7.9 Lt	692 7.7 Jo	699 8.1 Hf	700 10.7 Ar	*233815*	720 9.5 Wp
T TUC	693 7.9 Ah	700 8.3 Wd	703 10.7 Ar	652 9.8 Ht	720 9.5 Gy
223462	694 7.9 Ah	706 8.3 Ah	703 10.7 Pb	665 8.9 Ht	720 9.4 Fi
648 8.4 Ht	694 7.8 Sx	707 8.2 Ah	703 10.7 Hk	669 9.2 Ht	720 9.4 Wa
652 8.1 Ht	695 7.8 Ah	707 8.0 Hf	705 10.7 Pb	672 8.9 Bl	720 9.6 Kn
665 7.9 Ht	696 7.9 Ah	707 8.1 Jo	706 10.7 Pb	678 9.2 Ht	720 9.5 Mw
669 8.2 Ht	697 7.8 Ah	708 8.7 Fm	708 10.7 Pb	682 9.0 Ht	721 9.7 Cy
678 8.1 Ht	697 7.7 Sc	708 7.8 Je	708 10.7 Fr	682 9.6 Rb	721 9.7 Gy
682 8.1 Ht	699 7.8 Hf	710 8.1 Ah	708 10.7 Hk	684 8.3 En	723 9.7 Ma
684 8.3 En	700 7.9 Wd	712 7.8 Jo	708 10.7 Af	685 9.5 Si	727 9.8 Gy
688 8.4 Ht	706 7.8 Ah	713 7.6 Pt	711 10.7 Pb	685 9.6 Rb	Z CAS
697 8.1 Ht	706 8.0 Cm	713 7.6 Hz	711 10.1 Hu	686 9.2 Rb	233956
R LAC	707 8.0 Ah	715 8.0 Hf	711 10.7 Ar	687 9.0 Bc	703 13.1 Ar
223841	707 8.0 Jo	718 8.0 Kn	712 10.7 Cy	688 8.9 Ht	703 13.0 Pb
692 9.7 Jo	707 7.9 Hf	719 7.7 Cy	712 10.4 Jo	688 9.0 Bc	709[13.4 Bs
699 9.5 Hf	708 8.1 Gw	721 8.2 Hz	712 10.8 Ma	691 9.2 Rb	721[13.5 So
707 9.4 Hf	708 8.0 Sx	V PHE	713 10.3 Pt	692 9.9 Jo	RR CAS
711 9.3 Bs	709 8.0 Ah	*232746*	715 10.6 Hf	692 9.0 Ht	235053
713 10.4 Mc	710 8.1 Ah	652 12.3 Ht	718 10.8 Gy	693 9.3 Hf	684 11.3 Bn

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
RR CAS	R CAS	R CAS	R CAS	R CAS	Y CAS
235053	235350	235350	235350	235350	235855
690 11.3 Bn	683 5.7 Ah	699 6.1 Ah	709 6.3 Mn	720 6.6 Dl	692 10.8 Jo
695 11.5 Es	683 6.2 Se	699 6.4 Hf	709 6.4 Sx	Z PEG	694 11.3 Ra
718 12.2 Gy	685 6.2 Se	700 7.0 Cm	709 6.2 Hm	235525	712 11.0 Jo
721 12.2 So	686 6.0 Mn	701 6.3 Sh	710 6.3 Ah	692 9.3 Jo	721 12.1 So
723 12.0 Bn	689 5.7 Ah	701 6.4 Wd	710 6.4 Gl	694 9.1 Jo	SV AND
727 12.1 Gy	690 5.3 Sq	703 6.0 Ah	711 6.4 Gl	706 8.8 Jo	235939
V CET	691 6.0 Ah	706 6.1 Ah	711 7.1 Je	708 9.3 Hz	691 8.9 Kn
235209	691 6.1 Wd	706 6.1 Dl	711 6.6 Ar	712 8.7 Jo	692 8.9 Jo
672[12.3 Bl	691 6.2 Se	706 6.5 Wd	711 6.7 Pb	713 9.0 Pt	706 8.8 Jo
R TUC	692 6.2 Jo	706 6.0 Jo	712 7.0 B	713 9.5 So	709 9.1 Lt
235265	693 6.0 Ah	706 6.4 Gl	712 6.5 Jo	715 9.0 Jo	712 9.1 Jo
678 13.5 Ht	694 5.9 Ah	707 6.1 Ah	713 6.4 Dl	716 8.2 Fd	712 8.9 Ma
682 13.0 Ht	694 6.0 Ra	707 6.1 Hf	713 6.2 Gl	718 8.8 Gy	714 9.6 So
684 12.9 En	694 6.0 Sx	707 6.4 Gl	714 6.5 Wd	727 8.3 Gy	714 9.8 BH
688 12.6 Ht	695 5.9 Ah	708 6.5 Wd	715 6.5 Hf	W CET	715 8.9 Jo
697 10.6 Ht	696 6.0 Ah	708 7.0 Je	715 6.6 Jo	*235715*	718 9.4 Ie
R CAS	696 6.7 Je	709 6.1 Ah	716 7.2 Rc	692 9.8 Jo	719 9.5 Cy
235350	697 6.0 Ah	709 6.2 Dl	718 6.2 Gl	713 11.8 Jo	719 9.4 Kn
672 6.0 Je	698 6.1 Ah	709 7.0 Wh	720 6.5 Wd	721 11.6 Cy	723 9.7 Ma

RAPIDLY VARYING IRREGULAR VARIABLES.

Star J.D. Est.Obs.	J.D. Est.Obs.	Star J.D. Est.Obs.	J.D. Est.Obs.
005840 RX ANDROMEDAE—		060547 SS AURIGAE—	
7682.5 12.0 Ry	7708.7 11.7 Pt	7689.9 14.2 Ar	7715.7[12.5 Gy
7682.6 11.7 Ko	7709.4 11.6 Ry	7690.5[13.8 Ry	7716.7[12.5 Pt
7683.5 11.9 Ry	7709.6 11.5 Cy	7693.6[13.2 Ry	7717.9[12.6 Pt
7683.6 11.7 Ko	7710.4 11.6 Ry	7695.4[12.5 Ry	7718.8[13.9 Ie
7685.7 11.5 Ar	7711.8 11.6 Pb	7696.8 14.7 Ar	7719.7[12.5 Cy
7686.5 11.6 Ry	7711.8 11.5 Ar	7697.8 13.9 Ar	7720.7 10.8 Gy
7687.5 11.9 Ry	7712.6 11.5 Cy	7698.5[12.5 Ry	7721.6 10.7 Gy
7687.8 11.6 Sc	7712.7 11.7 Gy	7699.8[12.5 Ko	7721.7 10.9 Cy
7687.8 11.5 Ar	7712.7 11.6 Pt	7700.5[11.5 Ry	7721.7 11.2 Pt
7688.4 11.9 Ry	7713.6 12.0 Jo	7707.6[10.8 Gy	7722.7 10.8 Cy
7688.7 11.6 Cy	7713.7 11.8 Pt	7708.4[11.5 Ry	7723.6 10.9 Wa
7689.9 11.6 Ar	7714.6 11.7 Wp	7709.5[12.5 Ry	7723.6 10.9 Wp
7690.5 11.6 Ry	7714.6 11.8 Wa	7710.4[11.5 Ry	7723.7 10.7 Cy
7691.4 11.7 Ry	7714.7 11.9 Pt	7711.8 14.1 Ar	7724.7 10.6 Cy
7691.7 11.5 Kn	7715.6 12.2 Jo	7712.7[12.5 Jo	7724.8 10.7 Wp
7692.5 11.6 Ry	7716.7 12.0 Pt	7713.7[12.5 Pt	7725.7 10.6 Cy
7692.6 11.9 Jo	7717.6 11.1 Gy	7714.7[12.5 Pt	7727.7 10.9 Gy
7693.5 11.6 Ry	7717.7 11.7 Pt	074922 U GEMINORUM—	
7695.4 11.6 Ry	7718.6 12.0 Jo	7689.9 13.9 Ar	7720.7[12.4 Gy
7696.7 11.5 Ar	7718.6 11.5 Gy	7696.9 14.3 Ar	7723.8[12.4 Cy
7697.7 11.5 Ko	7719.6 11.8 Wp	7712.9[13.8 Ma	7724.9 14.3 Ma
7697.8 11.4 Ar	7719.7 11.7 Kn	7717.9[13.3 Pt	7725.8[12.4 Cy
7698.8 11.6 Ry	7719.7 11.7 Pt	7718.9[13.8 Ie	7727.8[13.3 Gy
7700.6 12.0 Wa	7719.7 11.5 Cy	7719.8[12.4 Cy	
7700.6 11.6 Ry	7720.7 11.2 Gy	081473 Z CAMELOPARDALIS—	
7700.6 11.8 Wp	7721.6 11.5 Gy	7682.4 13.1 Ry	7697.7 10.9 Ko
7702.4 11.7 Ry	7721.7 11.5 Cy	7682.6 12.6 Ko	7697.8 10.7 Md
7703.7 11.4 Ar	7721.7 11.6 Pt	7683.4 12.9 Ry	7698.5 10.9 Ry
7703.7 11.4 Pb	7723.8 11.5 Cy	7686.4 13.0 Ry	7698.6 11.2 Ko
7703.8 12.5 Hk	7725.8 11.5 Cy	7688.4 13.2 Ry	7698.7 10.9 Pt
7708.3 12.1 Ry	7727.7 11.7 Gy	7690.5 13.3 Ry	7698.8 10.9 Md
020356 UV PERSEI—		7692.5 13.5 Ry	7700.5 11.5 Ry
7720.6[12.7 Gy	7721.6[13.7 Gy	7693.5 13.4 Ry	7702.5 12.1 Ry
060547 SS AURIGAE—		7695.4 11.0 Ry	7708.7 12.6 Pt
7682.4[12.5 Ry	7687.9[13.9 Hk	7696.7 10.7 Md	7709.3 12.8 Ry

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
081473 Z CAMELOPARDALIS—						
	7712.7	12.6	Pt	7720.6	10.8	Gy
	7713.7	12.6	Pt	7721.6	10.9	Gy
	7714.7	12.8	Pt	7721.7	10.9	Cy
	7716.7	12.5	Pt	7721.7	11.0	Pt
	7717.7	10.8	Pt	7722.7	11.1	Cy
	7718.6	10.5	Gy	7723.7	11.6	Cy
	7718.7	10.9	Jo	7724.7	11.8	Cy
	7719.6	10.4	Cy	7725.8	12.1	Cy
	7719.7	10.8	Pt	7727.7	11.6	Gy
	7720.6	10.7	Cy			
094512 X LEONIS—						
	7717	[12.6	Pt	7727.9	[11.8	Gy
	7718.8	[12.3	Gy			
174406 RS OPHIUCHI—						
	7648.2	11.5	Ht	7705.6	11.8	Rb
	7652.3	11.5	Ht	7705.6	11.3	Cy
	7656.0	11.6	Kd	7705.7	11.4	Pt
	7660.2	11.4	Ht	7707.3	11.8	Ry
	7665.2	11.4	Ht	7708.6	11.8	Wp
	7677.3	11.4	Ht	7709.6	12.1	Rb
	7682.3	11.3	Ht	7709.3	11.8	Ry
	7682.4	11.8	Ry	7709.5	11.7	Wd
	7682.4	11.5	En	7709.6	11.0	Cy
	7685.6	12.1	Rb	7710.3	11.7	Be
	7686.3	11.7	Ry	7711.6	11.8	Hz
	7687.6	11.4	Bc	7712.6	11.9	Kn
	7688.6	11.4	Bc	7712.6	11.0	Cy
	7688.3	11.1	Ht	7712.7	11.2	Pt
	7688.4	11.6	Ry	7713.6	11.5	Jo
	7689.3	11.5	En	7714.6	11.4	BH
	7689.7	11.3	Cy	7715.5	11.6	Jo
	7691.4	11.6	Ry	7718.5	11.7	Gy
	7691.6	11.7	Kn	7718.5	11.3	Wd
	7691.7	11.3	Cy	7718.5	11.6	Jo
	7692.6	11.7	Jo	7718.6	11.9	Wa
	7693.4	11.7	Ry	7719.5	11.9	Wa
	7695.3	11.7	Ry	7719.5	11.9	Wp
	7698.7	11.4	Pt	7719.6	11.0	Cy
	7700.5	11.5	Hf	7719.7	11.1	Pt
	7700.6	11.9	Wp	7722.6	10.5	Hz
	7700.6	12.0	Wa	7722.7	10.5	Fm
	7700.6	11.6	Wd			
202946 SZ CYGNI—						
	7698.7	9.2	Pt	7713.7	9.3	Pt
	7701.7	9.2	Pt	7714.7	8.7	Pt
	7705.7	9.7	Pt	7716.7	9.5	Pt
	7706.7	9.6	Pt	7717.7	9.6	Pt
	7708.7	9.7	Pt	7719.7	9.5	Pt
	7712.7	9.2	Pt	7721.7	9.5	Pt
213843 SS CYGNI—						
	7667.7	8.1	Mw	7685.6	11.9	Fr
	7671.0	8.6	Hr	7685.6	12.0	Af
	7676.0	8.7	Hr	7685.6	12.0	Tr
	7678.0	10.7	Ka	7685.6	12.0	Ar
	7678.9	10.8	Ka	7685.6	12.0	Pb
	7679.0	9.6	Hr	7685.6	12.2	Hk
	7679.9	10.9	Ka	7685.7	11.9	Sc
	7682.6	11.9	Ko	7685.7	12.0	Lf
	7683.6	11.9	Ko	7685.7	12.0	Pk
	7685.6	12.0	Rb	7685.7	12.0	Ar
213843 SS CYGNI—						
	7686.6	12.0	Ko	7697.7	11.8	So
	7687.0	12.0	Hr	7697.7	12.0	Hk
	7687.6	12.2	Sc	7698.6	12.1	Wa
	7687.6	12.0	Gw	7698.6	12.4	Fr
	7687.6	12.2	Tr	7698.6	12.3	Ar
	7687.6	12.2	Ar	7698.6	12.3	Pb
	7687.6	12.2	Pb	7698.6	12.0	Ko
	7687.6	12.2	Hk	7698.7	12.4	Hu
	7687.7	12.2	Hu	7698.7	11.9	Pt
	7687.7	12.1	Fr	7699.6	12.0	Wa
	7687.7	11.8	Bc	7699.6	12.1	Wd
	7687.7	12.2	Lf	7699.8	12.1	Ko
	7687.7	12.2	Af	7700.5	12.1	Hf
	7688.7	11.8	Bc	7700.6	12.1	Wa
	7688.7	12.2	Lf	7700.6	12.0	Wd
	7689.4	12.0	Ah	7700.6	12.3	Pb
	7689.7	12.0	Cy	7700.6	12.2	Wp
	7689.8	12.2	Ar	7700.7	12.3	Ar
	7690.6	11.8	Bc	7701.5	12.0	Wd
	7690.6	12.2	Dh	7701.6	11.9	Wa
	7690.6	12.2	Af	7701.6	12.0	Wp
	7690.6	12.2	Ar	7701.7	11.9	Pt
	7690.6	12.1	Pb	7701.7	12.1	Pb
	7690.7	12.1	Hu	7702.5	11.6	So
	7690.7	12.2	Lf	7703.6	12.0	Wp
	7691.3	12.1	Ah	7703.6	11.9	Wa
	7691.6	11.9	Cy	7703.7	12.1	Hk
	7691.6	12.0	Sc	7703.7	12.1	Ar
	7691.6	12.3	Dh	7703.7	12.2	Pb
	7691.6	12.2	Pb	7703.8	12.1	Pb
	7691.6	12.1	Wd	7703.8	12.2	Ar
	7691.6	12.2	Kn	7704.5	11.9	Wa
	7691.7	12.3	Hu	7705.5	12.1	Fi
	7691.7	12.2	Lf	7705.5	12.0	Wa
	7691.7	12.0	Pk	7705.6	12.0	Cy
	7691.7	12.3	Ar	7705.6	12.3	Pb
	7691.7	12.3	Pb	7705.6	12.0	Wp
	7692.5	12.0	Ah	7705.7	11.8	Pt
	7692.6	12.2	Dh	7705.7	12.3	Pb
	7692.6	12.0	Jo	7705.7	12.2	Md
	7692.6	12.2	Ar	7706.5	12.1	Wd
	7692.6	12.2	Tr	7706.6	12.3	Fr
	7692.7	12.2	Lf	7706.6	12.2	Dh
	7694.4	12.2	Ah	7706.6	11.9	Jo
	7694.6	11.9	Jo	7706.6	12.1	Ko
	7694.8	12.0	Ra	7706.6	12.3	Pb
	7695.3	12.0	Ah	7706.7	12.0	Es
	7696.4	12.0	Ah	7706.7	12.3	Pb
	7696.7	12.1	Hu	7706.7	12.0	Pt
	7696.7	12.0	Ar	7707.5	12.0	Fi
	7696.7	12.0	Pb	7707.5	12.0	Wa
	7697.4	12.1	Ah	7707.5	12.0	Jo
	7697.6	12.0	Fr	7707.6	12.0	Wp
	7697.6	11.9	Sc	7707.6	11.9	So
	7697.6	12.0	Ar	7708.6	12.0	Hk
	7697.6	12.0	Pb	7708.6	12.1	Fi
	7697.7	12.0	Hu	7708.6	12.0	Wa
	7697.7	12.0	Lf	7708.6	12.3	Fr
	7697.7	12.0	Dh	7708.6	12.2	Af
	7697.7	12.1	Ko	7708.6	11.8	Bc

VARIABLE STAR OBSERVATIONS RECEIVED DURING OCTOBER, 1934.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.
213843 SS CYGNI—							213843 SS CYGNI—						
	7708.5	12.1	Wd	7712.5	12.0	Jo		7717.7	11.8	So	7721.6	11.5	Mw
	7708.6	12.0	Wp	7712.5	12.0	Hf		7717.7	11.9	Pt	7721.6	11.9	Kn
	7708.7	12.2	Af	7712.5	12.2	Bs		7718.5	12.0	Jo	7721.7	11.7	Cy
	7708.7	12.0	Pt	7712.5	12.2	Wp		7718.5	11.9	Hf	7721.7	11.7	Es
	7708.7	12.1	Hk	7712.6	12.0	Cy		7718.5	11.8	So	7721.7	11.9	Pt
	7708.7	12.0	Pb	7712.7	11.9	Pt		7718.6	12.2	Wp	7722.6	11.5	Wp
	7709.6	11.9	Rb	7712.8	12.0	Ma		7718.6	11.9	Sf	7722.6	11.7	Cy
	7709.5	12.0	Wd	7713.5	12.0	Jo		7718.6	12.0	Kn	7722.7	11.3	Wp
	7709.5	11.9	Jo	7713.6	12.0	Cy		7718.6	12.1	Wa	7722.5	11.7	Fi
	7709.6	12.1	Wp	7713.6	12.2	Wa		7718.7	11.9	Cy	7722.5	11.7	Wa
	7709.6	12.2	Wa	7713.6	12.0	Mw		7718.7	11.9	Gy	7723.5	10.5	Fi
	7709.6	12.0	Cy	7713.6	12.1	Wp		7719.5	12.0	B	7723.6	10.7	Wp
	7709.6	12.2	Fi	7713.7	11.9	Pt		7719.5	11.9	Fi	7723.6	10.5	Wa
	7709.7	12.0	Es	7713.7	12.0	Md		7719.5	12.0	Wa	7723.6	11.2	Ma
	7710.3	12.0	Ah	7713.7	11.9	So		7719.6	11.9	Wp	7723.7	10.5	Cy
	7711.6	12.1	Hu	7714.5	12.1	Wd		7719.6	12.0	Kn	7723.7	10.3	Es
	7711.5	12.1	Fi	7714.5	12.0	Jo		7719.7	11.7	Cy	7723.8	10.8	Ma
	7711.5	12.0	Wp	7714.6	11.9	Wa		7719.7	11.9	Pt	7724.5	9.9	Cy
	7711.7	11.8	Hv	7714.6	12.1	Wp		7720.6	11.7	Cy	7724.5	10.1	Fi
	7711.7	12.0	Fr	7714.6	11.9	So		7720.6	11.7	Fi	7724.6	10.1	Es
	7711.7	11.8	Bc	7714.6	11.9	Mw		7720.6	11.8	Wa	7724.6	11.1	Mc
	7711.7	12.1	Lf	7714.7	11.9	Pt		7720.6	11.8	Mw	7724.7	10.2	Wp
	7711.7	12.1	Dh	7715.5	12.1	Wd		7720.6	11.9	Kn	7724.9	10.1	Ma
	7711.7	12.0	Pk	7715.5	11.9	Jo		7720.6	11.9	Wp	7725.8	9.5	Cy
	7711.7	12.0	Ar	7715.7	11.9	Gy		7721.6	11.9	Wp	7727.7	8.1	Gy
	7711.8	12.0	Ar	7715.7	11.9	Pt		7721.6	11.8	So	7727.7	8.8	Md
	7711.8	12.0	Pb	7716.5	12.1	B		7721.6	11.7	Es	7728.6	8.7	Es
	7712.5	12.0	Wd	7716.7	11.9	Pt							

SUMMARY FOR OCTOBER, 1934.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	38	271	Halbach	Hk	58	131
Armfield, Mrs.	Af	21	58	Hamilton	Hm	6	10
Armfield, L.	Ar	60	241	Hartmann	Hf	63	150
Baldwin	Bl	89	155	Hassler	Hz	25	36
Ballhaussen	Ba	9	52	Heines	Hh	2	2
Belsham	BH	29	29	Houghton	Ht	86	420
Benini	Be	26	31	Houston	Hu	39	74
Boutell	BL	9	36	Howes	Hv	7	7
Bouton	B	32	33	Huruhata	Hr	7	16
Brown, A. N.	Bn	3	8	Iedema	Ie	16	18
Brown, S. C.	Bs	18	18	Jansen	Je	13	18
Buckstaff	Bc	15	36	Jones	Jo	149	439
Callum	Cl	6	8	Kaho	Ka	1	3
Christman	Cm	22	36	Kanda	Kd	10	30
Cilley	Cy	62	155	King	Kg	15	33
Czerniejewski	Cz	1	2	Kirkpatrick	Kp	9	32
Diedrich	Dh	14	45	de Kock	Dk	6	60
Doolittle	Dl	9	22	Kohman	Ko	22	60
Ellis	Es	29	45	Koons	Kn	35	46
Ensor	En	68	121	Loepfe	Lf	13	50
Field	Fi	17	34	Loreta	Lt	27	55
Fish	Fs	6	9	Lucas	Lu	10	37
Ford, M.	Fm	11	11	Marsh	Ma	42	51
Frister	Fr	28	78	McKnelly	My	20	57
Gregory	Gy	103	196	McLeod	Mc	26	113
Groeschel	Gl	3	20	Mennella	Mn	14	25
Grunwald	Gw	13	37	Millard	Md	28	48

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Miller	Mw	11	28	Seely	Sw	2	4
Moore	Mo	1	1	Shultz	Sz	6	6
Parthe	Pa	2	2	Simpson	Si	5	13
Peck	Pb	49	256	Smith, F. P.	Sq	15	20
Peltier	Pt	92	276	Smith, F. W.	Sf	15	24
Perkinson	Pk	12	19	Smith, L.	Sh	22	22
Poole	Po	2	2	Stosick	Sc	26	43
Preucil	Pf	16	23	Thurow	Tr	14	25
Raphael	Ra	22	28	Wade	Wh	7	7
Recinsky	Rc	11	40	Walton	Wu	13	17
Rosebrugh	Rb	8	42	Watson	Wa	36	112
de Roy	Ry	11	86	Webb	Wd	59	141
Ruben	Ru	6	15	Williamson	Wg	6	7
Salanave	Sx	29	52	Woods	Wp	60	121
Scanlon	So	56	82				
Schenkman	Se	6	17	Totals		84	426	5339

LEON CAMPBELL, Recorder.

November 16, 1934.

Comet Notes

By G. VAN BIESBROECK

Thirteen months have now gone by since the last unexpected comet was found 1933 October 21 by F. L. Whipple. This is a most unusual "drought" of comets especially when we keep in mind how frequently large areas of the sky are covered almost daily by photography in several observatories. If it had not been for some very inconspicuous known periodic comets there would not have been a comet visible for almost a year.

During the month of November two expected periodic comets have been recovered:

PERIODIC COMET REINMUTH 1928 I was reobserved photographically by H. M. Jeffers at the Lick Observatory as follows:

1934 Nov. 5.4061 $5^h\,11^m\,46^s.3$ $+11°\,47'\,9''$ Magnitude 16.

This is very close to the position predicted by A. E. Levin and J. T. Foxell who have used the elements for the 1928 apparition by L. Berman and F. L. Whipple and brought these up to date by taking into account the perturbations by Jupiter and Saturn. This comet comes to perihelion on 1935 May 2 but it will be unfavorably situated at that time and it is lucky that it was found several months ahead of that date. So far it appears as a minute round coma, and exposures made by the writer on November 12 and 15 show only a slight elongation that might lead to suspect a little tail. The following ephemeris requires the corrections —39ˢ and —8′ according to the position of November 5.

EPHEMERIS OF PERIODIC COMET REINMUTH 1928 I.

0^h U.T.	α h m s	δ ° ′	—Distance from— Earth	Sun
1934 Dec. 5	4 55 28	+11 19		
13	48 24	11 27	1.256	2.225
21	41 28	11 44		
29	35 28	12 12	1.244	2.157
1935 Jan. 6	30 56	12 49		
14	28 20	14 35	1.287	2.094
22	28 2	15 28		
30	4 30 5	+16 26	1.369	2.037

The position in the vicinity of Aldebaran is very favorable at this time but the object will remain faint although some brightening-up may be expected as the distance from the sun decreases. This is the first return since the discovery of this little comet which therefore becomes a well established new member of the solar system.

The other periodic comet whose presence was established by the writer from plates taken November 15 is COMET SCHWASSMANN-WACHMANN (1925 II). The following ephemeris by J. G. Behrens was used in locating this morning object:

	α	δ
0^h U.T.	h m	° ′
1934 Dec. 5	11 34.1	−1 32
13	35.9	1 52
21	37.1	2 9
29	11 37.9	−2 25

The position was as follows:

1934 Nov. 15.35536 $11^h 28^m 41^s.05$ −0° 40′ 23″.5 Magnitude 16

showing that the ephemeris required the correction: $+0^m.9$, −8′. This is the 16 year-period comet, moving between the orbits of Jupiter and Saturn, which has shown the most extraordinary changes in brightness and appearance during the previous oppositions. At this first observation the comet showed a diffuse coma fully a minute of arc in diameter and only feebly condensed toward the center. It will be of interest to follow its further behavior this season. Opposition does not come until 1935 March 10.

There is still a possibility that PERIODIC COMET ENCKE might be observed at low altitude in the evening sky this month. I have computed the following continuation of the ephemeris by N. Idelson in Circular 10 (Appendix) of the Poulkovo Observatory (June 1934). The correction is probably very small.

EPHEMERIS OF PERIODIC COMET ENCKE.

	α	δ
0^h U.T.	h m s	° ′
1934 Dec. 5	18 39 0	−26 46.0
9	18 50 7	32.1
13	19 0 47	26 15.9
17	11 2	25 57.7
21	20 53	37.8
25	30 22	16.5
29	19 39 32	−24 53.8

The comet sets about 1½ hours after the sun at our latitude and will therefore be seen only with great difficulty.

Ephemerides have been published for PERIODIC COMETS 1927 III (COMAS SOLA) and 1929 I (SCHWASSMANN-WACHMANN) which are expected to return to perihelion in the second half of 1935, in the hope that they might already be recovered at this early date. The search has not yet been successful and these comets are evidently extremely faint so long before their nearest approach to the sun.

An interesting contribution to the explanation of physical phenomena in comets is made by K. Wurm in *Zeitschrift für Astrophysik* (Vol. 8, p. 281, and Vol. 9, p. 62, 1934). He finds an explanation for the large velocities with which the gaseous particles seem to be ejected from the nucleus in the kinetic energy imparted to the products of photo-chemical dissociation of these atoms which emanate from the nucleus under the effect of the sun's heat but are broken up by the short wave radiation of the sun. He also calls attention to what might be

called the difference in life-time of the different types of molecules whose presence in the head or tail is revealed by characteristic band-spectra; this accounts for the fact that the neutral carbon compounds CN and C_2 are restricted to the head while the ionized carbon monoxide and nitrogen are the dominating elements in the tail. The change of intensity of the radiating field with varying distances from the sun leads to a natural explanation of the contraction of the coma and the broadening of the paraboloid envelopes near perihelion while the shorter life-time of certain elements explains the more or less distorted shells or envelopes of material which are seen surrounding the nucleus of bright comets.

Williams Bay, Wisconsin, November 21, 1934.

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

Observations on the Leonids were carried out by the Flower Observatory staff, augmented by volunteers, on four nights beginning on November 13-14. Weather conditions were excellent here, only the moon interfered somewhat on the last two nights in the first part of the watches. Coöperative work had been planned with six other observatories in the region. Such results as the meager display permitted will be reduced and published later, when all reports are in. In brief, the highest Leonid rate was only 8 meteors. Bright Leonids were conspicuous by their scarcity; no long-enduring train was left, nor indeed was any remarkable Leonid seen at all. As a "shower" it was miserably poor, and with its non-appearance seems to go our last chance for this cycle. While, of course, Leonids will be seen every November in future as in past, the expected richness of the display will probably be far inferior to that of either the annual Perseid, Geminid, or Orionid showers. Not until 1960 approaches can we hope for much from the Leonids unless, totally without expectation or known reason, they come in large numbers in the next year or two.

In briefly reviewing this cycle, we are struck with the fact that very good displays came in 1930 and 1931, but in no other of the seven Novembers from 1928 to 1934. Our information is based upon numerous reports from large numbers of observers, here and abroad. In the previous cycle good displays came in 1898 and 1901; very poor ones in 1899 and 1900. In the 1860-cycle the display was best in 1866, and still excellent in 1867 and 1868. We have explanations, based upon calculations of the perturbations, as to why the earth missed the stream in 1899 and 1900. We had hoped a partial reversal of the perturbative effects would have again thrown the main group so that its outer members would cross our orbit, and some published calculations bore out this expectation. That such was not the case merely means that the difficulty of following a meteor stream by calculation, under the handicaps which are inherent in this case, is almost insurmountable. It does not in the slightest give a proof that the Leonids have "dispersed" and that in future we will never again have a wonderful shower from them. Their history, with a few gaps only, runs back to 902 A.D.; they move in a retrograde and therefore most stable kind of orbit, and the mere fact that we are now missing them need not make us fear that the main group is breaking up. This indeed happened to the Bielids, but they moved in a relatively small orbit, with direct motion and small inclination, and hence every circumstance favored dispersion. The case of the Leonids is different.

Nevertheless their erratic behavior in this cycle will make predictions for the

1960-cycle almost impossible, and meteor observers of those years will simply have to hold themselves ready without much assurance as to what will happen.

The writer wishes to take this opportunity to express to many hundreds, if not thousands, of volunteers who have helped in the recent Novembers his sincere thanks for their enthusiastic and valuable aid. That they were not better rewarded is a matter of regret, but their coöperation has made possible a very complete study of the stream in recent years, to say nothing of the deriving of the most homogeneous and probably best data on heights ever secured. Therefore, while we witnessed no wonderful display like that of 1833, our labors have been rewarded by a real increase in our knowledge of meteors in general and the Leonids in particular.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1934 November 17.

How to Make Good Group Counts

By C. C. WYLIE

The number of meteors which could be seen in an hour on an average night by a large group arranged so as to cover effectively the entire sky has been used by Newton, Pickering, Wylie and others in estimating the total number which strike the earth per day. This number is, however, as yet known only roughly. It is estimated from the ratio of the total number seen by a large group to the number seen by a single observer. Available data indicate that this ratio is higher for carefully arranged groups, for fainter meteors, and on moonless nights, but more observations are desired. This is a good problem for groups of amateur astronomers, and useful results have been obtained by groups of boy scouts and girl scouts under adult leadership.

A site should be chosen where the sky can be seen almost down to the true horizon. Should there be appreciable interference from trees, buildings, or lights, in any direction, measure the angular height of the obstruction approximately and include the figures in the report. For the larger groups an outer circle, perhaps twenty-five feet in diameter, should watch just above the horizon. These persons will probably prefer to lie on their sides. A smaller inner circle should watch at a height a little more than that of Polaris; and one or more persons should lie on their backs in the middle to watch the region of the zenith. Should passing clouds interfere, let each observer watch his own region, even though it is obscured by clouds. He should call all meteors which he would see if alone and watching that region. A slowly-moving meteor seen because he turns involuntarily when some one else calls should not be recorded as his observation.

For groups up to twelve, one person not in the group can act as recorder. For larger groups we advise two recorders. Each observer should be assigned a letter of the alphabet, perhaps beginning with *A* for the observer in the outer circle watching due north. When a meteor falls, each person seeing it calls out his letter. The meteors seen are numbered consecutively, and after each number, the recorder writes the letters of all observers seeing that meteor. Thus, for each meteor seen, the observers are identified. For the large groups, when two meteors are called almost simultaneously, one recorder enters the first of the pair, and the other recorder the second. The watch time should be entered every fifteen minutes, and this, with the numbering of the meteors, will make it easy to later combine the two record sheets into one.

The following suggested arrangements for groups of various sizes have been worked out, keeping in mind coverage of the sky and convenience in reduction. To estimate the angular height of the center of the field of observation it is suggested that observers hold the hand at arm's length, with fingers spread. The angle subtended at the eye from tip of thumb to tip of little finger is between 20 degrees and 22½ degrees. Each observer should check the height at which he is supposed to watch.

Two to Six. For groups up to six arrange the observers in a circle, and watch at a height of about 35 degrees.

Seven. Use an outer circle of six watching at 35 degrees, with a single observer lying on his back in the middle to watch the zenith.

Eight. The same as for seven, but with two observers watching at altitude 75 degrees and on opposite sides of the zenith.

Nine. The same as for seven, but with three observers watching at altitude 75 degrees and 120 degrees apart in azimuth.

Ten. Use eight observers in the outer circle watching at an altitude of about 28 degrees, and two observers watching at an altitude of 75 degrees on opposite sides of the zenith.

Eleven. Use the same outer circle as for ten, with three observers watching at altitude 75 degrees and azimuth 120 degrees apart.

Twelve. Use again the same outer circle as for ten, with an inner circle of four observers watching at altitude 70 degrees.

Thirteen. Use again the same outer circle as for ten, with an inner circle of four observers watching at altitude 65 degrees, and in addition a single observer lying on his back to watch the zenith.

Fourteen. Use an outer circle of ten observers watching at altitude 25 degrees, and an inner circle of four observers watching at altitude 70 degrees.

Fifteen. Use an outer circle of ten observers watching at an altitude of 25 degrees, an inner circle of four observers watching at an altitude of 65 degrees, and a single observer lying on his back to watch the zenith.

Sixteen. Use an outer circle of 12 observers watching at an altitude of 25 degrees, and an inner circle of four observers watching at an altitude of 70 degrees. Or use an outer circle of ten observers watching at altitude 20 degrees, an inner circle of five observers watching at altitude 55 degrees, and a single observer lying on his back to watch the region of the zenith.

Seventeen. Use an outer circle of twelve observers watching at an altitude of 20 degrees, an inner circle of four observers watching at an altitude of 65 degrees, and a single observer in the center watching the zenith.

Eighteen. Use an outer circle of twelve observers watching at an altitude of 25 degrees, and an inner circle of six observers watching at an altitude of 70 degrees.

Nineteen. Use an outer circle of twelve observers watching at an altitude of 20 degrees, an inner circle of six observers watching at an altitude of 55 degrees, and a single observer watching the zenith.

Twenty. Use an outer circle of twelve observers watching at an altitude of 20 degrees, an inner circle of six observers watching at an altitude of 55 degrees, and two observers in the center watching at an altitude of 75 degrees.

Twenty-one. Use an outer circle of twelve observers watching at an altitude of 20 degrees, an inner circle of eight observers watching at an altitude of 55 degrees, and a single observer in the center watching the zenith.

Twnty-two. Use an outer circle of twelve observers watching at an altitude

of 20 degrees, an inner circle of eight observers watching at an altitude of 50 degrees, and two observers in the center watching at an altitude of 75 degrees and on opposite sides of the zenith.

Twenty-three. Use an outer circle of twelve observers watching at an altitude of 20 degrees, an inner circle of eight observers watching at an altitude of 50 degrees, and three observers in the center watching at an altitude of 75 degrees and 120 degrees apart in azimuth.

Twenty-four. Use an outer circle of twelve observers watching at an altitude of 20 degrees, a second circle of eight observers watching at an altitude of 50 degrees, and a third circle of four observers watching at an altitude of 75 degrees.

For convenience in reduction, it is suggested that, as far as possible, groups which are multiples of four be used. The largest group which has reported a systematic count is sixteen. We hope that some groups of twenty-four can be organized for the Geminid meteors.

University of Iowa, November 21, 1934.

Dubuque Counts of the 1934 Leonids

Observations of the 1934 Leonid meteor shower were begun at Columbia College, Dubuque, Iowa, on the morning of November 12. On that morning the sky was somewhat unfavorable, yet sufficient activity was in evidence to assure a shower equal to that of a year ago.

Plans had been made to continue observations night after night till the shower would be over, but after the night of November 15 all observations were made impossible by a persistence of a completely overcast sky. On the mornings of November 13, 14, and 15 the sky was perfectly clear. The counts obtained on these nights show a marked increase toward the dawn hour of November 15. At that time the group rate ran over 70 Leonids per hour.

The student observers worked in shifts of two hours. Each group was headed by a captain and by a recorder, both of whom had been selected on account of extensive experience in meteor observation. In addition to group counts, the plan of observation included solo counts for the peak nights of the shower, and satisfactory solo counts were obtained for the morning of November 15. After this date all counts became impossible on account of cloudy skies. Each of the solo observers held a record of more than twenty-five hours of previous experience in meteor observation during major showers.

In addition to the Leonid counts, the observers likewise made a count of sporadic meteors. A comparison of the data shows a tendency of parallel frequency in Leonids and sporadic.

All counts were made in 15-minute periods. Data on sky conditions, number of observers in each period and the identity of the solo observers were recorded. The times given are noon-to-noon reckoning and for the 90th meridian.

The following is a summary of the Dubuque counts of the 1934 Leonids and also of the sporadic meteors observed during the same time.

		—Group Count—		
Date	Period	Leonids	Sporadic	Remarks
Nov. 12	14:30-15:30	10	1	Partly cloudy; two observers
13	14:15-16:00	34	14	Clear; two observers
14	14:15-16:15	82	29	Clear; four observers
15	13:30-17:30	190	75	Clear; five observers

The following named persons participated in the observations: Robert

Becker, Robert Ernsdorff, Leonard Jaeger, Lester Cooling, Merlin Conlon, Francis Hellstern, Joseph Keating, Albert Hansen, Paul Hacker, Billings Richards, Nick Lies, Jack Clancy, Charles Sonnkalb, Thomas Seymour, Jack Gottschall, Paul Evans, Robert Thill, Aloys Rudolph.

JOHN A. THEOBALD.

Columbia College, Dubuque, Iowa.

Notes from the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD, President, and H. H. NININGER, Secretary

The Roy Aërolite

By H. H. NININGER

The Roy aërolite was found in the spring of 1933 by a Mexican farmer, Mr. Fidel Landfer, about eleven miles east and one mile south of the village of Roy, Harding County, New Mexico. This location is in longitude W. 104° and latitude +35° 56′.

At the time of its discovery, the aërolite must have been a rather handsome stone, if we may judge from the appearance of the fragments which passed into the hands of the writer in May, 1934. The history of this find is a sad one, and should serve to emphasize the importance of a widespread knowledge of the recognition marks of meteorites, which the writer has so often urged.

Mr. Landfer and a friend came upon this stone on some grazing land not far from his house. As described by him, and as is evidenced by the fragments preserved, the stone must have been about 100 lbs. in weight. Apparently it was complete, and it was evidently very strongly pitted over a considerable portion of its surface. It was partially exposed on a hillside; this fact, and also its weathered condition, would indicate that it had been buried in the soil and had subsequently been uncovered by erosion.

The finder, being attracted by the unusual appearance of the stone and by its weight, suspected it of containing some precious metal, and so, after he had hauled it to his residence, he began a search for the suspected contents by means of a sledge! In this search he was assisted by his friend, and, though they complained of the toughness of the stone, they vigorously pursued their task until the yard was strewn with fragments!

When the survey of the March 24, 1933, fall brought the writer into northeastern New Mexico, and information was broadcast regarding the appearance of various types of meteorites, two pieces of the Roy stone were sent to Pasamonte (where he had made his headquarters), for inspection. They arrived too late, however, and were turned over to an amateur, who, guided by the Nininger survey, had gone to Pasamonte in the hope of sharing the fruits of the investigation. After paying for the pieces of the supposed meteorite, this man concluded that they were not meteoritic, and accordingly sent them back to their former owner, who threw them out into the yard of the Pasamonte ranch-house. Here it was, that, on a subsequent trip to this ranch, the writer espied these fragments, and recognized them as being pieces of a meteorite. Inquiry finally led him to the original location, 42 miles away, where 71 lbs. of fragments were gathered together. Thus may be seen by how narrow a margin this meteorite escaped being completely lost!

There are thirty-five States in the Union in which there is not exhibited an aërolite as fine as this one evidently was when first seen by Mr. Landfer. It is probable that specimens just as good are destroyed, every year, unrecognized. If

only there could be exhibited in each institution of learning a small representative collection of meteorites, it is probable that the number of finds resulting from such exhibits would soon make possible at least one large collection within the borders of each State.

The Roy aërolite has not been studied petrographically. A chemical analysis shows no very great difference from that of the Melrose, New Mexico, meteorite, except in the particular that, in the Roy stone, there is no trace of gold.

This find shall be known as the Roy aërolite. It is the fourth aërolite of *unwitnessed* fall to be recorded for the State of New Mexico. The only *witnessed* fall so far recorded for this State is that of March 24, 1933. All of these five meteorites were recovered through activities of the survey which is being conducted by the Nininger Laboratory. The meteorite is preserved, mainly in the Nininger collection in Denver and in that of the U. S. National Museum, in Washington, D. C.

The chemical analysis of the Roy aërolite, made by Mr. F. G. Hawley, is as follows:

	%
FeO	12.57
Fe_2O_3	13.29
NiO	1.27
CoO	0.14
CuO	0.10
Cr_2O_3	0.43
Al_2O_3	2.92
TiO_2	0.12
MnO	0.16
CaO	2.50
MgO	23.10
K_2O	0.06
Na_2O	0.26
SiO_2	36.95
SO_3	0.69
P_2O_5	0.31
FeS	3.58
Loss on ignition	1.88
Total	100.33

Content of Pt metals = 0.05 oz. per ton.

After writing the foregoing account, the writer has received from Mr. Landfer 33 lbs. more of fragments, broken from evidently the same stone. These additional pieces bring the total weight of the material recovered from the Roy aërolite to 104 lbs.

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By Frederick C. Leonard *and* Robert W. Webb

[Continued from p. 344. *Anonymous* articles are listed under the *periodicals* in which they were published.]

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Asteroid Notes

By HUGH S. RICE

It is claimed by Captain Wm. Henry Smyth (*A Cycle of Celestial Objects*, 1844), that Kepler "from a deep conviction of the harmony of the solar system . . . became persuaded that an undiscovered body must exist in the vast space between Mars and Jupiter." Too large a gap existed between the orbits of these objects. It will be remembered how a Professor Bode also had an ingenious scheme calling for such an extra planet, and which received such attention that Baron de Zach busied himself with computations of the "latent body." This baron with five other German astronomers established a society of 24 observers whose duty was to observe all telescopic stars in the zodiacal regions, in order if possible to bring to light the unseen object.

One of these observers was Professor Piazzi of Palermo. He took note on January 1, 1801, of a small star-like point in Taurus, during his systematic searching; by the next night it had moved by 4^m in R.A., and 3'.5 in Decl. For several days he followed it, but (the histories say) illness prevented further continuation, until finally it was lost in the sun's rays. Then came the magnificent genius of Gauss, a German mathematician, who invented means of locating it again from the scant observational data. It is said that here was the first use of "least squares" solutions. Gauss computed an approximate orbit of the strange object, so that it was rediscovered on December 31, 1801.

Ceres was the name applied to the new body by Piazzi. Ceres was supposed to be surrounded by a "nebulous haze," and so was first said to be a comet; in fact, Piazzi thus announced it to the world. Smyth says that it appeared "like a ruddy star." The present writer has not confirmed this opinion as to color, but it is hoped that observers who pick up planet 1 Ceres will carefully note the color, the constancy or variability of same, and compare it with that of Vesta. We mentioned before the color of Vesta, and now Mr. T. M. Day, making observations with a 5-inch from Plainfield, New Jersey, says that he was "particularly struck by the deep color of the asteroid," which seemed to him to be orange.

The chart in the preceding issue of this magazine covers the apparent path of Ceres through December, and extending into January. Soon after leaving the vicinity of 15 Cancri it will go into the domain of Gemini, where it will appear to be headed for Castor. We should not be surprised to find Ceres and Castor both in the same binocular field about the middle of January. This will be one of the times when it will be the very easiest to locate this object; anyone wanting to see it should utilize such opportunity. We shall continue its path in a diagram in the January number.

There appears something in each of two corners of the Ceres chart in the November number, which is not meant for an interrogation point, but is the old form of the symbol for Ceres. This was taken from Smyth. A newer form is practically the same but reversed, giving us a capital C with a small cross underneath; the latter form is seen in almanacs such as "The Old Farmer's Almanac" published yearly in Boston. In this publication one finds articles on "Recent Comets" and "New Stars" side by side with "The Usefulness of Toads" and "Fish Laws." These symbols of the first 4 asteroids have long ago fallen into disuse, which is probably just as well, for with one of them—the symbol of Vesta—it is much more difficult to draw it than to write out the word a few times. Pallas' symbol is reproduced in the corners of the chart on p. 407, this magazine.

Certain observers have asked for positions of planetoids of a fainter magnitude

than that of the brighter ones we have been showing. For the benefit of such personages—and we are pleased to hear of this activity—we are therefore copying selected ephemerides from the material supplied by the *Astronomisches Rechen-Institut*. It is suggested that 944 Hidalgo be searched for. This is an extraordinary asteroid. The eccentricity is very large, of Hidalgo's orbit, and at aphelion it goes out as far as Saturn, though it cannot come close to the latter planet. The orbit plane is highly inclined, 43°. It is only visible for a year or two, Dr. Crommelin says, in its long period of about 14 years, so that its orbit looks cometary.

EPHEMERIDES OF MINOR PLANETS, FOR 0^h G.C.T.

198 Ampella [Eq. 1925] $11^M.0$				944 Hidalgo [Eq. 1934] $13^M.0$			
	α		δ		α		δ
	h	m	° ′		h	m	° ′
Dec. 13	6	41.1	+22 18	Dec. 13	0	10.4	+23 16
21	6	32.0	+21 51	17	0	9.8	+24 3
29	6	22.6	+21 23	21	0	9.8	+24 51
Jan. 6	6	13.6	+20 56	25	0	10.4	+25 40
14	6	5.7	+20 31	29	0	11.7	+26 29

American Museum of Natural History, New York, November 21, 1934.

Notes from Amateurs

Amateur Telescope Makers of Chicago

The Amateur Telescope Makers of Chicago held their monthly meeting on November 11 in the lecture room of the Adler Planetarium and Astronomical Museum.

Professor Arthur Howe Carpenter opened the meeting and said the project of building the community observatory for LaGrange was going ahead. He is going to furnish a 15-inch speculum and supervise the making and setting of the mounting. There is to be a meeting in LaGrange to which the members of the club are invited.

Dr. Roy K. Marshall of the Planetarium staff spoke on Spectroscopy and Photography. He gave an outline of the use of spectrography and told of the importance of the spectrograph in modern astronomy. He also described the characteristics of the different plate emulsions used in spectrography and explained the uses of each.

WM. CALLUM, *Secretary*.

1319 West 7th Street, Chicago, Illinois.

Astrolab Progress Report

Astrolab would reply to Hans D. Gabler's article, "The Telescope as a Means to an End," published in the October (1934) issue of POPULAR ASTRONOMY, as follows:

Amateur observers of the future will have more to learn from textbooks, but they will not be as interested in getting their information there as they will have the whole sky for their laboratory.

There will be more astronomical books because more enthusiastic observers will be gathering information. Nightly after the evening meal they will sit in an inclosed comfortable arm chair in their own yard, and as the stars march over head they will watch their passing in their own telescopes. Near at hand will be their star maps and reference material should they wish to examine some fellow-worker's efforts. In winter, the snow will be a soft blanket banked up against the

shelter, but the observer's electric pad will keep him warm, and, as his telescope will not be inside, the small quantity of heat necessary for comfort produced by the modern electric pad will not adversely affect the seeing. Overhead the stars will be visible through the transparent dome of his enclosure, around about him if he cares to look will be the great out-of-doors, or if the reflection from the snow is too great he can pull his curtains and shut out whatever extraneous light he pleases. In the summer, the garden flowers surrounding him will be visible and their fragrance will be with him as he observes; no mosquitoes will be able to reach him as between the observer and the garden is a protective wire screen.

In the daytime as well as in the moonlight the observer's workshop can be a thing of beauty in the garden plot. In even the smallest garden the observatory can have its place for all the family to treasure and keep its surroundings beautiful. The transparent roof may even be built so as to form the dial of an enormous sun dial, whose hours are written in the garden itself. When not in use for actual observing the short telescope, in itself a thing of beauty and easily lifted by any adult, will be kept inside the observer's shelter.

Such an observing workshop, either on the roof or in the garden, could become a joy to all who see it, and to the child of the family the value of acquaintance with the stars above him would come from his own home circle. A space no larger than twelve feet in diameter should permit the working out of such a design.

Today we have all the tools—the short compact reflector of good resolving power, coatings that make the reflectivity of the telescope mirror permanent, new light-weight materials of aluminum, glass cloth, and cello wire, which make possible the building at relatively low expense such a shelter for the observer.

What now is necessary is the vision and coöperation of many observers to work out the details of construction. Give the observers modern comfort and their telescopes will be in use.

L. I. Buttles.

10728 S. Artesian Avenue, Morgan Park, Chicago, Illinois.

An Exhibit of the Work of Amateurs

The Amateur Astronomers and Telescope Makers of the United States, as yet an unorganized body of enthusiastic workers in the fields of astronomy and optics, will have an enviable opportunity to exhibit their wares at the next convention of the American Association for the Advancement of Science, to be held in Pittsburgh, from December 27 to 30 inclusive, at the new Mellon Institute, the finest building of its kind in America.

The building is of that type of classical Greek Architecture known as Ionic; it is plain but massive, and is surrounded by sixty-two monolithic columns. Indiana limestone and granite are used throughout the exterior. The proportions of the building are about 300x275 feet, and there are nine floors. The main entrance, which is on the fourth floor, is reached by steps extending along the entire front of Fifth Avenue. The laboratories face on interior courts. The erection of this edifice was commenced in 1930; special attention is being accorded to finishing the laboratory rooms on the fifth and sixth floors. It is expected that the building as a whole will be ready for occupancy in the fall of 1935.

The Science Exhibition in connection with the convention is an annual feature of this Association's activity, and the one this year in Pittsburgh promises to establish an all time record for its interesting material. Amongst other material of equal interest there will be exhibits on cosmic rays, heavy water, stratosphere flights, public health, zoology, chemistry, physics, and metallurgy.

THE MELLON INSTITUTE, PITTSBURGH, PENNSYLVANIA.

The Astronomical Section of the Academy of Science and Art of Pittsburgh, acting in the name of the amateurs throughout the States, has been granted suitable space to exhibit the products of their workmanship. Leo J. Scanlon, Secretary of the Pittsburgh group, has been appointed Chairman of the Astronomical Exhibition Committee, and will be assisted by enthusiastic colleagues in that organization.

As outlined at this time, the exhibit will include the following:

Telescopes and Accessories. Several completed amateur instruments, one from Indianapolis, one from Youngstown, and one from Pittsburgh. Machined Mirror Cell and eyepiece end of telescope from Detroit. Assortment of amateur-made eyepieces from Achromatized Kellners to Hastings type "d" solids; focal lengths from .1-inch to 2-inch inclusive. Mirror blanks of fired Porcelain from Massachusetts, built-up Ritchey type from Ohio, Ribbed boro-silicate crown and other recent developments from Chicago, including one stainless steel mirror. Pyrex flats correct to a twentieth of a wavelength will be shown from Ohio; spectroscope is being sent from New York and will be used with a spectra demonstration instrument being built in Pittsburgh, showing three spark spectra, one continuous, and half-a-dozen gases. In addition an amateur will be at work on a small telescope mirror throughout the exhibit, to show his methods of making a glass; there will be two completed mirrors, one good and one bad, under test for visitors; Focault and Ronchi tests will be used. An amateur refractor of fifty years ago will be contrasted with one recently completed in Ohio, 7¾-inch aperture, complete with circles and driving mechanism.

Celestial Photography. At this writing a number of 8x10-inch transparencies have been received notably from Riverside, California, and San Diego; others have been sent after this article had been written, and a complete list of all will be published when report of the convention is covered in this journal.

Meteor Display. A comprehensive section devoted to meteorites is being arranged in conjunction with the Society for Research on Meteorites, with the coöperation of H. H. Nininger, of Denver.

Variable Star Section. Material for this exhibit is being arranged by Leon Campbell, recorder of the American Association of Variable Star Observers, with headquarters at Harvard.

Publications and Journals. Papers, pamphlets, books or magazines devoted to amateur's interest in astronomy or telescope making will be on display, and should be contributed by those publishing same upon seeing this notice.

Since the American Association for the Advancement of Science is open to membership for the amateur as well as the professional, we would welcome correspondence from groups giving their idea of the feasibility of making this our recognized amateur astronomers and telescope makers society in the United States.

LEO J. SCANLON.

Valley View Observatory, Pittsburgh, Pennsylvania.

Zodiacal Light Notes

By FRANKLIN W. SMITH

The morning Zodiacal Light was observed from 5:00 to 5:20 E.S.T. on November 7. The northern boundary passed about two degrees north of δ Virginis, approximately through ι Leonis, and about midway between α and η Leonis. The southern boundary passed approximately through φ, π, and ο Leonis. The light cone could be traced to a point slightly west of Praesepe at an elongation of about 102° from the sun. On the morning of November 15, from 4:20 to 4:40, the Zodiacal Light was somewhat more conspicuous than on the occasion just mentioned. This effect was probably due to more favorable atmospheric conditions. The boundaries were approximately the same as before; the light cone could be traced westward to an elongation of about 109°. The axis of the light cone, as located by these reference points, was probably a degree or two south of the ecliptic.

The Gegenschein is now approaching the Milky Way, and for that reason was not seen.

407 Scott Avenue, Glenolden, Pennsylvania, November 17, 1934.

General Notes

Professor George Van Biesbroeck, astronomer at the Yerkes Observatory of the University of Chicago, has been awarded the honorary degree *Doctor Honoris Causa* by the University of Brussels.

Professor Willem de Sitter, director of the Leiden Observatory, and known the world over for his important contributions to astronomical science, died on November 20, in his sixty-third year. An account of his work will be given in a subsequent issue.

The Rittenhouse Astronomical Society of Philadelphia held a meeting on Friday, November 9, in the Hall of The Franklin Institute, Twentieth Street and the Parkway. The program consisted of an illustrated lecture by Dr. Samuel G. Gordon, Associate Curator of Mineralogy, Philadelphia Academy of Natural Sciences, on the subject "Stones from the Sky."

The American Astronomical Society will hold its fifty-third meeting at The Franklin Institute, Philadelphia, Pennsylvania, December 27-29, 1934. Professor R. S. Rugan, Secretary, in the announcement says:

"The meeting will open on Thursday, December 27, so it will not interfere seriously with your Christmas. The morning session will be held at The Franklin Institute, the afternoon one, on the invitation of Professor Olivier, at the University of Pennsylvania. In the evening, at The Franklin Institute, Dr. Adams will give his address as retiring president. This will be followed by a reception tendered by the Rittenhouse Astronomical Society.

"Professor Gummere has invited us to come to Haverford for both sessions on Friday. In the evening we shall have our "Society dinner" at Hotel Sylvania. The first award of the Annie J. Cannon Prize will be made after dinner. If you wish to make an after-dinner speech and are quite sure that you can make a good one you should write to the president.

"On Saturday we hope to persuade Mr. Stokley to open with a special demonstration of the planetarium. An afternoon session is being scheduled in case of need."

Alvan Clark & Sons Company

This company has been well known as the maker of optical and astronomical instruments of the highest quality since 1850. About a year ago, the firm was bought by the Sprague-Hathaway Mfg. Co., of West Somerville, Massachusetts. The opticians and instrument makers who had been employed at the plant for many years were all re-employed by the new owner, so that the same skilled workmanship is still available. In fact, there has been a continual succession of opticians from the time of the first Clarks, the terms of the older men overlapping the terms of the beginners, so that although none of the Clarks themselves are in the firm at present, many of the practices which they originated have to some extent been brought down to the present and are still effective in the original plant.

The transfer of the ownership to the Sprague-Hathaway Co. will add to the optical skill of the early firm much experience along mechanical lines which is valuable in the construction of telescope mounting and, further, the new company is large enough to undertake large orders and able to carry out any such undertaking.

During the past summer, Dr. Leland S. Barnes became technical adviser and the hope now is that, with the combination of the backing of the new owners, Mr. Thonet's mechanical experience, the shop experience of the old Clark employees, and the technical and astronomical knowledge of the adviser, the Clark plant will not only go on with its old record of quality but will be able to improve it.

TROPIC NIGHT IN DECEMBER

The ship's south-pointed days are singing birds.
I fare to summer with them happily,
But night's high fields are strange. The heavenly herds
That roam my purple north are gone from me.
Polaris on the far horizon sinks
Where Lyra, Draco, and the two Bears drown,
Though affably the Centaur's near star winks;
And who could greet Canopus with a frown?
I keep deck-vigil who have waited years
For this night's watch. I am alone with storm
Which hides my hopes and thunders at my fears.
Dawn tears a cloud-rift. In it, cruciform,
Above the eastern billows' heave and toss,
Behold four long-sought stars—The Southern Cross!

LILIAN WHITE SPENCER.

1490 Stuart Street, Denver, Colorado.